Report of the Bureau *of* Engineering

1921 and 1922

Department of Public Works
City and County of
San Francisco

M. M. O'SHAUGHNESSY.
City Engineer

3 1223 04140 4147

REPORT

OF THE

BUREAU *of* ENGINEERING

OF THE

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF
SAN FRANCISCO

FISCAL YEARS ENDING
JUNE 30, 1921, AND JUNE 30, 1922

JAMES ROLPH, JR. - - - - *Mayor*

TIMOTHY A. REARDON
DANIEL G. FRASER
CHARLES E. STANTON
Board of Public Works

M. M. O'SHAUGHNESSY
City Engineer

Digitized by the Internet Archive
in 2013

http://archive.org/details/reportofbureauof19211924s

POINT LOBOS AVENUE

With slopes of Sutro Heights on one side and Pacific Ocean on the other. (Showing the Cliff House and Seal Rocks.)

Report of the Bureau of Engineering

DEPARTMENT OF PUBLIC WORKS

CITY AND COUNTY OF SAN FRANCISCO

1920-1921 and 1921-1922.

INTRODUCTION

The following report is a resumé of the Annual Reports of the Bureau of Engineering for the fiscal years 1920-1921 and 1921-1922.

Within the first half of this period industrial and financial conditions greatly hampered construction activities. Wages and prices of building materials were at their highest mark and efforts to reduce wages resulted in an industrial strike and practical cessation of building construction for five months. Because of these conditions, few contracts for public work were awarded by this Department during that period. Upon the resumption of work most of the local activities inside the City limits have been confined to street and boulevard improvements, as, due to the rapid growth of motor traffic, it has become necessary to widen many of our paved crosstown arteries of travel and to improve and pave new routes.

Meanwhile studies and investigations were made in connection with many important and necessary projects and as the preliminary work has been completed we shall be ready to proceed immediately with actual construction when funds are available. Numerous requests have been made for extensions of the Municipal Railway System to the outer districts of the City. As the City is committed to the policy of municipal ownership of its activities, it is the hope in the coming period some arrangement will be made for the

purchase of the Market Street Railway on a basis that will be fair to the citizens and just to the Company.

Work on the Hetch Hetchy Project has proceeded with great activity in the past two years. It has been the only period when adequate funds have been available to prosecute construction. An unauthorized strike was called by tunnel workers in August 1920 which blocked all construction for a period of three months and seriously embarrassed progress on the project until the following February. Very nearly 1,800 men are now employed on the project. The main Hetch Hetchy Dam should be completed by January, 1923, the balance of the mountain tunnels should be completed by August, 1923. Priest forebay dam is over 50 per cent completed at the present time and should be finished inside of a year. The tunnel and penstock grade to Moccasin Creek power house are under way. Contracts for the water wheels and generators for the power house have been awarded and all parts of the mountain division should be completed in two years from date.

Work on the Bay Division, 22 miles long, from a point near Niles to Crystal Springs Reservoir, is under construction, consequent on an order of the State Railroad Commission of California. The Pulgas Tunnel, 9,000 feet long, is under construction, through the ridge about 2 miles west of Redwood City toward Crystal Springs. Rights of way have been obtained for the balance of the pressure pipe line, while at the same time an option was obtained to purchase the Spring Valley property at any time within 10 years for $38,000,000. This work should be done in 2½ years.

Details of the different projects under construction are given in full in the attached report.

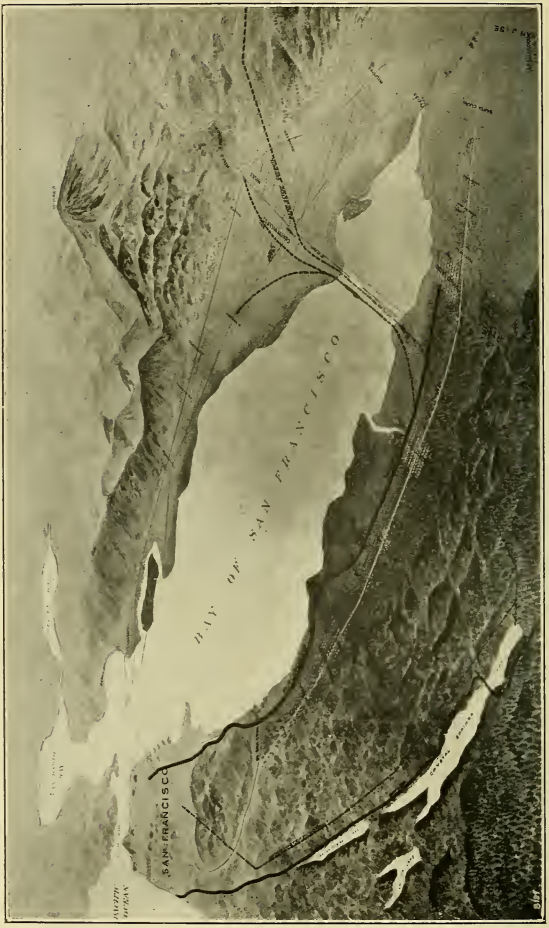
M. M. O'SHAUGHNESSY,
City Engineer.

BOULEVARDS, STREETS AND HIGHWAYS

For years Mission Street was the only paved direct route from the heart of the City, connecting with the main peninsular highway of San Mateo County to the south. Due to the adjacent large business section, it soon became too congested to accommodate the increasing volume of rapid vehicular traffic. One of the first problems met by this office in its campaign for better streets was the development of main routes of travel paralleling Mission Street.

Junipero Serra Boulevard and San Bruno Avenue were the natural selections for two main additional highways. In 1913, Junipero Serra Boulevard, from Sloat Boulevard to the County Line, was paved for a width of 25 feet with asphalt, the City paying $52,000 from its funds for this improvement. A section of San Bruno Avenue was graded and paved, payment for which was made by the property owners; another section improved through the financial co-operation of the City and property owners, and other sections by City funds alone. These three principal traffic routes lead from different sections of the city, but, through the plan which has been evolved, the system of cross connecting thoroughfares gives ready access from these main routes to all parts of the City.

Boulevards such as the Twin Peaks drive, encircling the summits of the Twin Peaks, and the Great Highway, the beautiful Ocean Beach drive, are of value mainly to the pleasure seekers and their construction is fully justified by their great use by pleasure vehicles. The greater portion of the system, though, serves the economic need for well paved, direct and short connections on easy gradient between sections of the City, and over which the products and necessities may be moved. The values of these roads were well brought out during the World War, when the constant movement of large amounts of military and naval supplies and industrial



SAN FRANCISCO BAY REGION
Showing Proposed DUMBARTON BRIDGE and PENINSULAR HIGHWAYS.

products by trucks was amply taken care of without congestion by San Francisco's highway system.

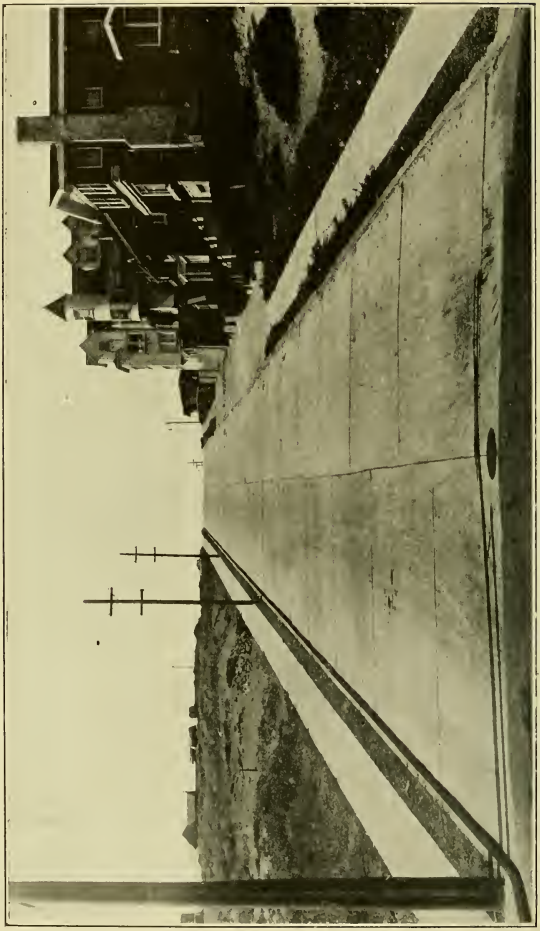
Auxiliary roadways, paralleling the main routes leading to the City's exits are now necessary and being developed. Howard Street and San Jose Avenue are two examples, both of which serve to relieve Mission Street of some of the traffic.

San Francisco's geographical location has proven a handicap in many respects, chief of which is its contracted physical connection with the surrounding territory and cities. Situated on the extreme end of a narrow peninsula, bounded by the Pacific Ocean and the San Francisco Bay on three sides, San Francisco has but one direction in which it can expand, and that is southward "down the Peninsula." Topographical features of the City have limited the location of the natural outlets in this direction.

With the roadways through these exits completed or being developed, San Francisco has awakened to the fact that its main roadways lead into one highway outside its limits—and that this present peninsular highway cannot carry the enormous traffic to and from this City. The problem of remedying this condition is not alone San Francisco's problem but is of vital interest to all the peninsular cities and counties. The Sky Line Boulevard, west of Lake Merced and through the Spring Valley lakes in San Mateo County, one unit of which is now under construction, will aid in relieving the congestion by diverting the pleasure vehicles over this scenic route. The proposed 125-foot highway along the bay shore now being studied by the engineers of San Francisco, San Mateo County and the State Highway Commission, offers another source of relief.

Types of Pavement Constructed:

The first pavement laid in San Francisco was the plank road to Mission Dolores, 2½ miles in length, completed in 1850. Other plank roads were constructed. Round cobble



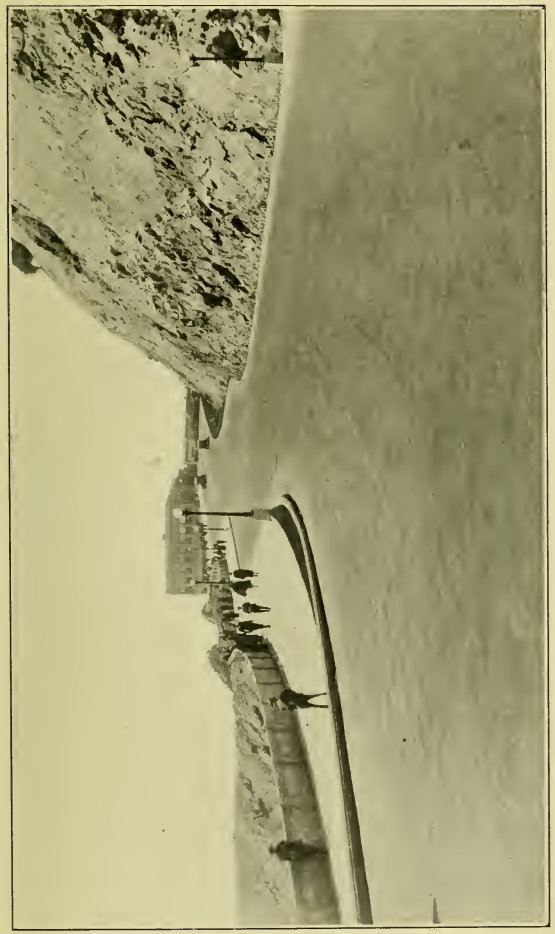
CONCRETE PAVEMENT
Forty-fifth Avenue between Anza and Balboa Streets.

stones were utilized for paving the heavy traffic streets, also on steep grades. Later, basalt blocks were substituted for the planks and cobbles, except on the very steepest grades where the cobbles were allowed to remain, and in many instances still remain in these days. Basalt blocks have retained their usefulness as paving material on heavy traffic streets but are now laid on a concrete base. Bituminous rock and asphalt wearing surfaces on a concrete base replaced the other types of pavement, except on heavy traffic streets and upon the steeper grades. In the early days of bitumen or asphalt pavement, a thick wearing surface was thought necessary or a heavy intermediate binder course with a moderately thick wearing surface was used. While noiseless and resilient, the thick courses rolled under the heavy traffic and formed large waves in the surface. Today no bituminous rock pavements are being laid in this City, but an asphaltic concrete pavement, consisting of a 1½-inch asphaltic concrete wearing surface on a 6-inch concrete base, is used extensively. The asphaltic concrete is composed of asphalt cement between 8 and 11 per cent by weight, and mineral aggregate (sand, stone dust and broken stone) between 89 and 92 per cent. This makes an excellent noiseless and to a certain extent non-skid pavement.

Brick pavements have been constructed on many of our streets and have proven especially satisfactory for heavy traffic and for steep grades.

During the past few years several streets in San Francisco have been paved with concrete. Concrete pavements were an innovation in this City in 1919. Many types of pavement in use have concrete base but the first concrete pavement, consisting of a monolithic 6-inch concrete slab with no top course of any kind, in San Francisco, was laid on Winfield Street between Eugenia and Esmeralda Streets in that year. Since then over 400,000 square feet of concrete pavement have been constructed in this City.

CLIFF HOUSE ROAD IN 1881



POINT LOBOS AVENUE (CLIFF HOUSE ROAD) IN 1922

The following excerpt from the Ordinance which prescribed the use of concrete pavement, definitely sets forth where and how it may be used:—"Concrete pavement shall be limited in use to roadways of alleys, cul-de-sacs, and streets other than main traffic arteries and shall not be constructed on roadways with a greater width than twenty (20) feet, except where the gradient exceeds ten (10) per cent. The prerequisite to the use of concrete as a pavement shall be that the roadway by nature and by location relative to other streets, will not serve heavy or concentrated traffic."

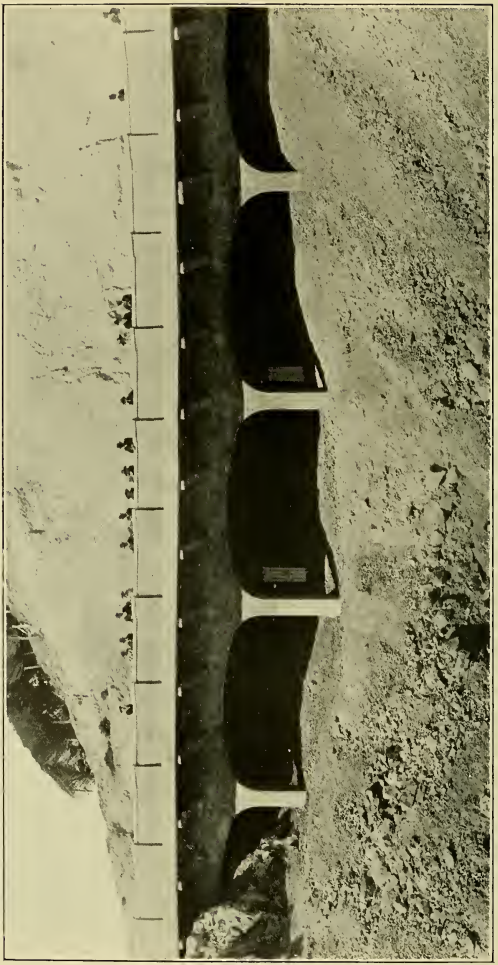
For streets of narrow width and light traffic, concrete pavement provides a reasonably priced and good wearing pavement. Wide streets necessitate numerous unsightly expansion joints in concrete pavements and the joints are a source of failure in this type of pavement. Under heavy traffic, the concrete ravels at the joints and the corners of the slabs break off. For paving on grades, where traffic is light, concrete is more economical than brick. Elimination of the glare, due to the whiteness of the concrete, would tend to make concrete pavements more popular with the public.

Point Lobos Avenue:

One of the most important roadway projects instituted and completed during the past year was the improvement of Point Lobos Avenue, commonly known as Cliff House Road, from Forty-eighth Avenue to the north end of the Great Highway, being practically the continuation of the latter highway northerly around Sutro Heights.

The Cliff House Road, in its most picturesque setting, with the steep unstable slopes of Sutro Heights on one side and the precipitous cliffs and Pacific Ocean on the other, has been traveled by practically every visitor and resident of our City since the early days of San Francisco. It is as

POINT LOBOS AVENUE
Upper section around Sutro Heights.



VIADUCT SUPPORTING POINT LOBOS AVENUE AT OCEAN'S EDGE

widely known as Market Street, sharing its fame throughout the world with the Cliff House and the Esplanade.

The topographical situation, while an aesthetic benefit, has presented many difficult problems in the attempt to construct an 80-foot highway in place of the old narrow road. The resulting highway, 2,400 feet in length, with a maximum grade of 9 per cent, has been proclaimed by press and public one of the most magnificent driveways, ranking with our unexcelled Twin Peaks Drive as a scenic boulevard and an example of up-to-date engineering. A broad winding 60-foot wide roadway, paved with asphaltic concrete on each side of a brick center strip, and with an adjoining 20-foot cement walk, is supported on the Ocean side by massive rubble walls laid in concrete. The highway spans a rock gorge by means of a reinforced concrete half-bridge, 173 feet in length. The slopes of Sutro Heights have been cut back to insure stability, over 39,000 cubic yards of excavation being necessary in the construction of the roadway, mostly in trimming the slopes. The other features of construction included 134,000 square feet of asphaltic pavement, 23,700 square feet of stone sidewalk, 4,300 cubic yards of rubble masonry wall, 3,930 feet of ironstone pipe sewer, 10 manholes and 20 catchbasins. A system of ornamental lighting standards and electric lights was installed, adding to the beauty and utility of the improvement.

The contract for the work was awarded on September 23, 1921, and construction was completed in the early part of June 1922, in time for the great influx of Eastern visitors brought to San Francisco by the many conventions held here this year. The construction involved a total expenditure of $190,000.

Market Street Extension:

The paving of the easterly section of this boulevard, as described in our last report, was completed during the early

MARKET STREET EXTENSION.
View of Paving of Easterly Section (looking East from Douglass Street). Kiosks Cover Stairways to Eureka Valley Station of Twin Peaks Tunnel.

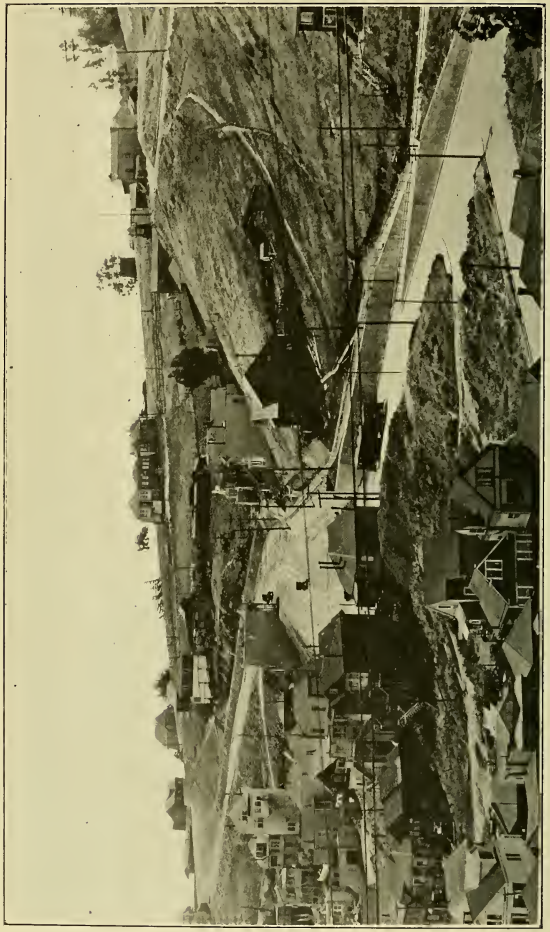
part of this fiscal year. In addition to this, there has been completed the grading and sewering of a section from the easterly termination of Mono Street to a junction with Corbett Road at Twenty-fourth Street, and the paving has since been contracted for under public proceedings. This section of the boulevard extends approximately 3,850 feet and has a 46-foot roadway and 8-foot sidewalks.

The contract for grading and sewers included 41,600 cubic yards of excavation, and construction of five retaining walls and over 5,800 feet of sewers. The estimated quantities of work under the present paving contract include 170,500 square feet of asphaltic concrete pavement, 55,000 square feet of artificial stone sidewalks and 6,700 feet of concrete curb. The cost of paving this section will be assessed to the property owners, up to a rate of $10 per front foot; any excess above this amount will be paid for by the City.

The completion of this section will provide a direct paved route from the Ferry Building via Market Street, Market Street Extension, Eighteenth Street, Portola Drive, to Junipero Serra and Sloat Boulevards, thus shortening the distance between the western residential district and the main business district of the City. Formerly, travel between these districts was compelled to take a circuitous route over Haight or Fell Street and Lincoln Way to Nineteenth Avenue, or a southerly route over Valencia and Mission Streets and Ocean Avenue.

Great Highway:

The paving of the easterly portion of the Great Highway from Fulton Street to Lincoln Way has been completed. This contract, awarded on May 21, 1920, covered the paving of 141,326 square feet, being a strip 43 feet wide along the Ocean frontage of Golden Gate Park, the width of paved roadway in this section of the Highway now being 83 feet.



MARKET STREET EXTENSION, MONO STREET TO 24TH STREET
View after grading.

The contract for paving of the westerly portion of the Great Highway between Balboa and Cabrillo Streets, awarded on July 2, 1920, has been completed, and included, with 36,350 square feet of paving, the construction of coping and walks about the new Comfort Station at the beach.

A contract has been let for the paving of the westerly portion of the Great Highway from Cabrillo Street to Fulton Street. This improvement is adjacent to the recently completed section of the Esplanade, and will complete the paving of the Great Highway between Point Lobos Avenue and Fulton Street to a full width of 150 feet, which is contemplated to be carried eventually across the Park frontage to the junction of the upper and lower roadways.

Sloat Boulevard:

The paving of a 30-foot strip on the northerly half of Sloat Boulevard from Great Highway to Fortieth Avenue was extended in the same contract to Thirty-fifth Avenue. The proposed full width of 135 feet will consist of a 20-foot sidewalk and parking strip and a 30-foot paved strip on each side of a 35-foot street railway right of way. The southerly strip of pavement has been in use several years and the northerly section from St. Francis Circle to Nineteenth Avenue and from Thirty-fifth Avenue to Great Highway is now paved. The last contract just completed added 126,000 square feet of paved surface to this highway.

Laguna Honda Boulevard:

The boulevard extending from the southerly end of Seventh Avenue around the Laguna Honda Reservoir of the Spring Valley Water Company to Dewey Boulevard was improved. From Lawton Street to Plaza Street, around the reservoir, being 3,845 feet in length, the road was paved in a temporary manner with an asphaltic concrete surface of 2 inches minimum thickness on the existing macadam base,

LAGUNA HONDA BOULEVARD
Southerly section at the Relief Home. Laguna Honda Station of Twin Peaks Tunnel at the left.

a minimum width of 12 feet being maintained. A design for a permanent road around this reservoir has been made and will be constructed in the future when the final determination, as to how much this reservoir will be enlarged, is reached. From Plaza Street to Woodside Avenue, over 60,000 square feet of pavement, consisting of 1½-inch asphaltic concrete wearing surface on a 6-inch concrete base, was constructed. The Relief Home Tract and also the Laguna Honda Station of the Twin Peaks Tunnel front upon this latter section. The improvement of this road provides a level thoroughfare from Golden Gate Park to the Dewey Boulevard and connecting highways.

Geneva Avenue and Walbridge Street Improvement:

The existing road through Visitacion Valley was improved by rolling an 8-inch course of broken rock on a 12-foot strip. This improvement runs along Geneva Avenue from Prague Street easterly and thence along the existing roadway to Walbridge Street, thence along Walbridge Street to the County Line. The roadway below the County Line to San Bruno Avenue has been similarly improved and Geneva Avenue has been paved from Prague Street to Mission Street. This route is the only improved through route between San Bruno Avenue and Mission Street south of Silver Avenue and provides a means of diverting traffic between these highways.

Divisadero Street Widening:

Divisadero Street, one of the old built-up streets of this City, has developed into a main crosstown thoroughfare. This street, with a double track railway in the center of a 44-foot 6-inch roadway and with 19-foot sidewalks on each side, acquired such traffic that it became necessary to widen the roadway. Eight feet were added to the width of the pavement for a distance of 20 blocks between Haight Street

and Clay Street, by reducing the sidewalks on each side to 15 feet.

In the design of this work, special attention was given to the existing improvements so as to minimize the amount of conform work and to create the least disturbance to the traffic. It was necessary to construct 47,790 square feet of asphaltic concrete pavement and to place only 7,385 square feet of conform surface on the undisturbed portion of the adjoining pavement.

In addition to this 12,670 lineal feet of granite curb was redressed and reset, 69 catchbasins were reset and culvert pipes connected and 199 sewer traps and connections reconstructed.

The total cost of this work was $31,563.70, of which amount the property owners were pledged to pay $17,081.73, being at the rate of $1.5859 per front foot. The balance of the cost, together with the cost of setting back the fire hydrants and inspection fees, was borne by the City.

This improvement has proven satisfactory in relieving the traffic congestion on this street, which fact alone well repays the property owners for the amount of their contributions.

Castro Street Widening:

A contract for widening Castro Street from Seventeenth Street to Nineteenth Street has been let and the work partially completed.

This improvement is similar to that on Divisadero Street and consists in widening the roadway 4 feet on each side for a distance of two blocks by setting back the curbs and reducing the walks accordingly. This work is estimated to cost $8,350, which cost the City and property owners will share alike.

San Jose Avenue, Ottawa Avenue to Sickles Avenue:

This portion of San Jose Avenue has been widened to a uniform width of 80 feet, the City purchasing the necessary property on the easterly side of the avenue. In addition to paying for the property, the City contributed $30,000 towards the cost of grading and paving, and this improvement is nearly completed. Before the southerly end of this avenue, between Sickles Avenue and the County Line, can be widened and improved it will be necessary to replace the narrow wooden bridge over the Ocean Shore Railway at Regent Street and San Jose Avenue with a wider, more suitable structure. The northerly end of this improvement is intended to merge into the Bernal Cut.

Proposed Boulevards:

Surveys have been made and tentative plans prepared with a view to the acquisition of necessary lands for the **Telegraph Hill Boulevard** and also for the extension of the **Marina Boulevard** to the Presidio.

Roosevelt Way: Practically 95 per cent of the property needed for Roosevelt Way has been acquired and a contract for part of this improvement should be let shortly. This boulevard will extend from Fourteenth and Alpine Streets to Seventeenth and Clayton Streets, and traverse a district that at the present time has no main artery of easy gradient. It will be approximately 3,900 feet long, 60 feet in width with 6-foot sidewalks. The maximum gradient will be about 10 per cent. Retaining walls will have to be used quite extensively, the highest wall measuring about 15 feet in height.

Bernal Cut: Plans, both in perspective and section, of the Bernal Cut improvement were prepared and show the important relation of this proposed boulevard to the surrounding district. The improvement would consist of widen-

ing the cut of the Southern Pacific Railway from Randall Street southerly to San Jose Avenue to a clear width at the bottom of 116 feet, and thus provide room for a 42-foot roadway, a double track street railway line, a double track suburban line of the Southern Pacific Company and an 8-foot sidewalk. The right of way through the existing Bernal railway cut was secured for the City as a part of the Southern Pacific Company's franchise at Third and Townsend Streets. The necessary grading to accommodate the paved roadway was made an obligation of the railway company. The completed roadway will be the northern link of a new boulevard extending from the County Line along San Jose Avenue and through Bernal Cut to the southerly termination of Dolores Street. From Ocean View northerly, 4,000 feet of San Jose Avenue has been widened to a uniform width of 80 feet. Another mile to Sunnyside Avenue is being prepared by obtaining rights of way, etc., so that the approaches of the "Cut" from the south will be completed at an early date.

Special Street Improvements:

One of the larger special local improvements upon which construction has commenced is the grading, sewering and construction of walls on Liberty Street from Noe to Church Street and Sanchez Street from Twentieth Street to Twenty-first Street. Plans have been drawn up and proceedings for the ordering of the work started many times in past years, but heretofore it has been impossible to satisfy even a majority of the property owners with the proposed plans. The evil of a rectangular system of streets on a steep hillside is well illustrated by this case. Combined with this handicap is the fact that property owners have erected homes on the abutting properties without regard to any practical plan for street improvements. The work under way is estimated to cost approximately $60,000, towards which the City

SPECIAL TREATMENT IMPROVEMENT ON QUESADA AVENUE
Showing double roadway with wall and turning space at further end.

has contributed $24,000 and the property owners affected will be assessed to pay the balance.

The improvement of Quesada Avenue between Railroad Avenue and Newhall Street was completed. This involved the construction of a double roadway with retaining walls, steps and terraces, and the construction of sidewalks, sewers and pavement. Revere Avenue from Newhall Street to Railroad Avenue and London Street from Amazon Avenue to France Avenue were also improved under special treatment designs.

Plans have been prepared for the following special improvements involving walls, terraces, steps, etc., and which are to be paid for mainly by the adjoining property owners:

Saturn Street from Ord Street to Lower Terrace.

Twenty-second Street from Arkansas Street to Wisconsin Street.

Chestnut Street from Polk Street to Larkin Street.

Lombard Street from Hyde Street to Leavenworth Street.

Coso Avenue from Prospect Avenue to Winfield Street.

Mars Street from Seventeenth Street to Corbett Avenue.

Broadway from Taylor Street to Jones Street.

Grand View Avenue and Market Street.

Burnham Street and Market Street.

Collingwood Street from Twentieth Street to Twenty-second Street and Twenty-first and Twenty-second Streets from Castro Street to Diamond Street.

Diagrams and Working Plans for Street Paving:

San Francisco has at the present time approximately 502 miles of paved streets. With such a considerable mileage to care for, there results naturally a very appreciable amount of reconstruction that must be made annually, in

order that the high standard of the City's pavements be maintained. Over $800,000 was expended during the past two fiscal years by the Department of Street Repair in the reconstruction of paved streets. Working diagrams were prepared by this Department for all such work of reconstruction and also for new pavement construction.

Among the most important reconstructed pavements were the following:

Pacific Street, Embarcadero to Van Ness Avenue.

Clay Street, Drumm to Battery Streets.

Front Street, California to Jackson Streets.

Howard Street, Twenty-fourth to Twenty-fifth Streets.

Minna Street, Fourth to Seventh Streets.

Third Street, Army Street to Islais Creek.

Columbus Avenue, Washington Street to North Point St.

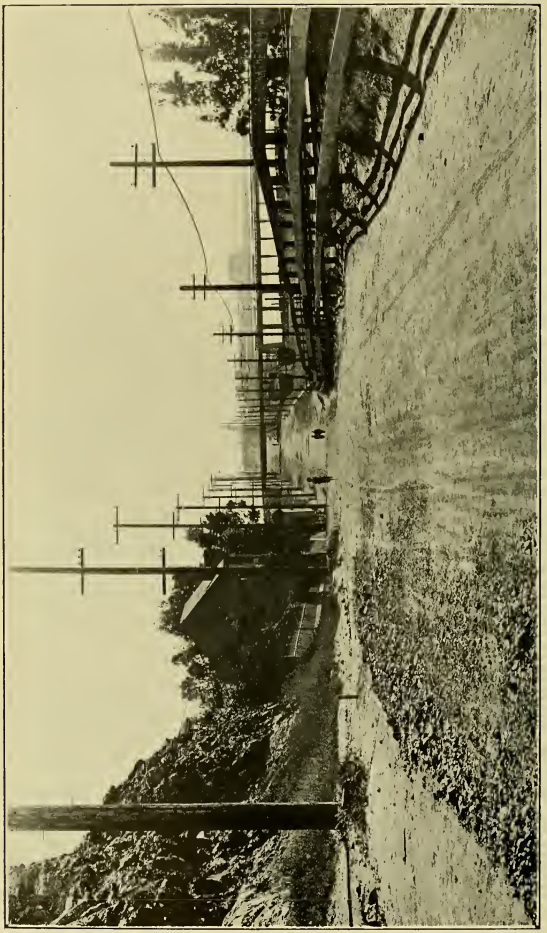
Howard Street, the Embarcadero to Fifth Street.

Townsend Street, Fourth Street to the Embarcadero.

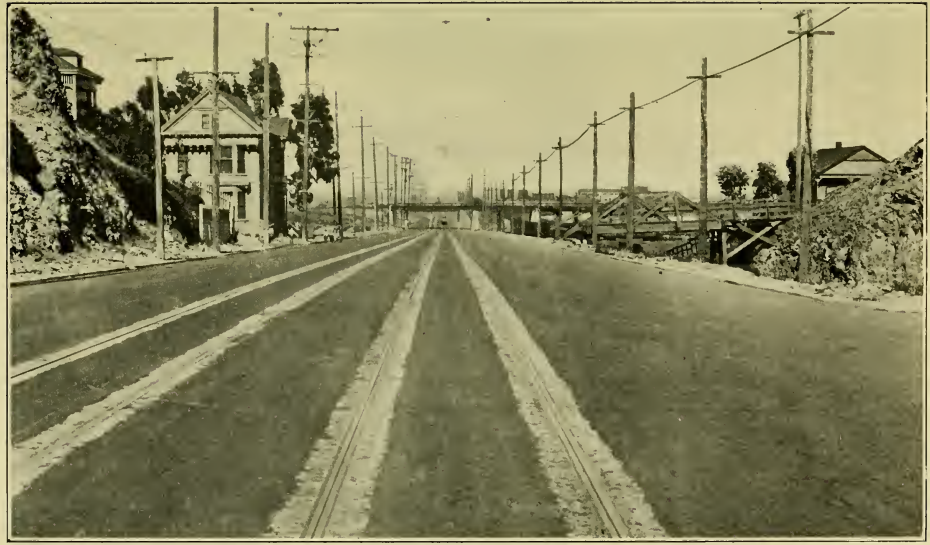
As Columbus Avenue is the second most important diagonal thoroughfare of the City, the improvement of this street was probably of the greatest general benefit. Unusual difficulties were encountered in the preparation of plans for this improvement due to the chaotic condition of the lines and grades thereon.

Complete working plans were made for street improvements which were constructed under public, private and City pay contracts, the aggregate cost of which, for the two-year period, was approximately $1,700,000. In addition to the boulevard and special street improvements described in the preceding pages, some very important units were added to the City's fast growing total of paved streets and boulevards. Among these improvements were the following:

Army Street, DeHaro Street to Third Street.



ARMY STREET, DeHARO STREET TO THIRD STREET
View looking easterly before improvement.



ARMY STREET—WIDENED, PAVED AND WITH STREET RAILWAY
This view looking easterly after improvement of the street is of the same section of Army Street as shown in preceding illustration.

Ulloa Street, Twenty-seventh Avenue to Thirty-fourth Avenue.

Balboa Street, Thirty-third Avenue to Forty-seventh Avenue.

Cabrillo Street, Forty-fifth Avenue to La Playa.

Plymouth Avenue, Lakeview Avenue to Farallones Street.

Forty-fifth Avenue, Anza Street to Balboa Street.

Circular Avenue, Sunnyside Avenue to Santa Rosa Avenue.

Townsend Street, Fourth Street to Eighth Street.

Twentieth to Twenty-sixth Avenues (inclusive), Taraval Street to Ulloa Street.

Army Street is the most important connecting industrial highway in the southeast section, and is destined to be one of the key thoroughfares of that district. Townsend Street carries a large amount of heavy traffic to and from the railroad freight sheds and other warehouses in the neighborhood. The reconstruction of this street from Fourth to Eighth Streets was done under the inspection of this Department at the expense of the Southern Pacific Company, which is also liable, as a franchise obligation, for maintenance of the pavement.

Over 2,000 location plats were made for side sewer installations. In preparation for this latter work, which was recently taken over by this Department, copies of approximately 2,000 side sewer diagram and examination sheets were made and filed under the block number system and indexed on a large City map. By this system considerable time is saved in locating connections for side sewers, and breaking into the main sewers is reduced to a minimum.

Railroad profiles and grades were also furnished by this Department to the Market Street Railway Company for practically all of their track reconstruction work.

STREET WORK PERFORMED UNDER CONTRACTS

	Fiscal Year 1920-1921		Fiscal Year 1921-1922	
	Quantity	Cost	Quantity	Cost
Asphalt Pavement, 6" concrete base—				

STREET WORK PERFORMED UNDER CONTRACTS

	Fiscal Year 1920-1921 Quantity	Fiscal Year 1920-1921 Cost	Fiscal Year 1921-1922 Quantity	Fiscal Year 1921-1922 Cost
Asphalt Pavement, 2" ... base—				
Existing surface 2"	14,[illegible]7 sq. yds.	$ 42,2[illegible].51	13,562.2 sq. yds.	$ 38,230.72
[illegible] 1½"	[illegible] " "	512.70		
[illegible] 1½", [illegible]r [illegible]	1,[illegible]7.7 " "	4,8[illegible]5.21		
Asphalt Pavement, ... vitrified brick ... 6" ... base—				
Wearing surface 2"			268. " "	578.88
Standard brick			160. " "	561.21
Asphalt Pavement—				
Wearing surface (Cushion)	88.2 " "	212.34		
Asphaltic Concrete Pavement 6" ... concrete base—				
Wearing surface, 1½", [illegible] road	[illegible].1.2.4 " "	395,726.72	143,709. " "	296,455.58
Asphaltic Concrete Pavement, with ... vitrified brick strip 6" ... concrete base—				
Wearing surface, 1½", gutter road	2,[illegible]7.[illegible] " "	8,010.81	1,920. " "	5,011.20
Vertical fibre brick	1,[illegible]27.4 " "	8,456.11	746.7 " "	4,368.00
Asphaltic Concrete Pavement, 1½" ... on 6" ... concrete base—				
Wearing surface 1½"			1,376.1 " "	3,096.25
Asphaltic Concrete Pavement, on ... existing ... macadam road—				
Wearing surface 2" [illegible]	9[illegible].5 tons	8,913.79		
Asphaltic Concrete Pavement—				
Wearing surface (Cushion)	[illegible]1.4 sq. yds.	1,010.70	875.9 " "	616.52
Asphaltic Binder Filler	[illegible]6 tons	184.80		
Vitrified Brick Pavement, ... vertical fibre	1,[illegible] sq. yds.	6,224.81		
Concrete Pavement 6"	13,[illegible].4 " "	18,[illegible]0.29	19,422.3 " "	57,802.80
Bessen Brick Pavement			5,133.3 " "	2,739.19
Curbs—				
[illegible] (new)	[illegible]	2,476.37	601.8 ft.	918.66
[illegible] (new)	[illegible]	469.77	13,[illegible]5.6 "	9,891.97
[illegible] (new)	[illegible]	[illegible]410.73	[illegible],[illegible]7.6 "	60,586.00
[illegible] (new)	[illegible]	1,[illegible]8.8	1,[illegible]1.7 "	608.85
[illegible] Curbing	[illegible]	[illegible]8.9	[illegible]4.4 "	112.29
[illegible] Curbing	[illegible]	[illegible]8.85	65. "	26.00
Coping—				
[illegible]	[illegible]	[illegible]8.8		
[illegible]	[illegible]	[illegible]9.19	132.6 "	132.20
Retaining—				
Vitrified [illegible]	[illegible] sq. yds.	[illegible]4.74	11,899 sq. yds.	19,984.32
[illegible]	[illegible]	44.56		4,000.00
[illegible]	[illegible]	[illegible]	[illegible] " "	205.10
Iron Fences at Back ...	[illegible]	9,[illegible]6.5	1,170.8 " "	4,423.78
Guides—				
[illegible]	[illegible]	[illegible]8.73	1[illegible].9 " "	471.91
[illegible]	[illegible]	[illegible]4.24	[illegible] " "	1,740.00
Grading—				
Cut	[illegible]9,[illegible]7.[illegible]	$ 99,[illegible]7.51	112,[illegible]3.3 cu. yds.	$100,987.13
Fill	[illegible],[illegible]8.[illegible]	27,[illegible]1.[illegible]	9,573.8 " "	8,170.50
Stairs, Walks and Coping— [illegible]		1,714.33		100.00

CONTRACTS—(cont'd)

	Fiscal Year 1920-1921		Fiscal Year 1921-1922	
	Quantity	Cost	Quantity	Cost
Retaining Walls—Concrete	.....	5,400.00	.....	36,900.00
Bulkheads—Timber	.....	400.00	.....	.....

STREET WORK PERFORMED UNDER CONTRACTS—Cont'd

	Fiscal Year 1921		Fiscal Year 1921-1922	
	Quantity	Cost	Quantity	Cost
Retaining Walls—Concrete				36,900.00
Bulkheads—Timber				
Pipe Railings				
Guard Fence	841.2 ft.	2,328.90	485. ft.	1,156.50
Sewers—			1,138. "	682.80
Terra cotta pipe				
6" (city sewer)	282.5 "	565.00	704. "	1,408.20
8"	1,[illegible] "	17,380.44	9,146.2 "	35,602.17
10"	324.	727.75	417.	895.01
10" Y's	286.5 "	672.96	563.8 "	1,338.00
12"	24.	48.00	2.	5.00
12" Y's	7,[illegible] "	98,671.72	8,228.4 "	28,437.25
15"	228.	543.60	308.	770.30
15" Y's	4,180.7	9,[illegible]	1,712. "	6,953.60
18"	72.	149.95	90.	128.00
18" Y's	2,[illegible] "	6,240.12	1,040.7 "	7,002.50
24"	50.	153.75	23.	95.00
24" Y's	[illegible] "	2,[illegible]	315. "	3,190.00
Reinforced Concrete	7.	35.00	16.	48.00
2' x 3' with 6" I. & P. [illegible]				
3' x 3'			917. "	10,821.60
Terra cotta [illegible]			543. "	1,995.00
Sewer Traps and Connections—Cement			1.	120.00
Manholes—			199.	995.00
On 1. & P. sewers [illegible]	83.	2,[illegible]	165.	13,747.10
" " [illegible]			4.	300.00
" Concrete "			2.	150.00
Lampholes	6.	8.[illegible]	1.	100.00
Catchbasins—				
New				
Reset	107.	[illegible]	144.	20,197.00
Castings [illegible]	3.	240.00	39.	3,930.00
Stormwater Inlets	20.	1,[illegible]	24.	1,732.50
Culverts—			2.	75.00
18" I. & P.	4,[illegible] ft.	8,[illegible]	1,381.7 ft.	10,866.98
15" I. & P.			41. "	370.00
Miscellaneous—Curbing, Drainage hauling, [illegible]		1,[illegible]		186.15
Total Costs		[illegible]		$815,227.86

SUMMARY—COST OF STREET WORK

	Fiscal Year 1920-1921	Fiscal Year 1921-1922
Work under public contracts	$407,272.79	$363,244.85
" " private "	3[illegible],491.82	282,585.37
" " city pay "	165,442.18	169,397.64
Total Costs	$881,210.09	$815,227.86

SEWERS.

Canal Street Sewers:

Two contracts were let and completed for sewers to carry the sanitary sewage from the Sunnyside, Glen Park, and Lower Mission Street districts, through the built up district southeast of Mission Street Viaduct before releasing it into Islais Creek. These two sections were constructed, one being a 24-inch pipe sewer 905 feet in length, in Canal Street from Mission Street easterly, and the other, also a 24-inch pipe sewer, being an extension of the first from Canal Street over a private easement to the easterly end of Trumbull Street, a distance of 475 feet. At a later date, when the College Hill sewer tunnel will have been completed, the Canal Street sewer will not be needed as an outlet but may be used as a local sewer.

Beach Street Sewer:

There has been completed a 15-inch pipe sewer in Beach Street from Polk Street to Columbus Avenue, to divert the sewage from Polk Street to the North Point Outfall which empties into the outgoing currents of the Bay at the foot of Grant Avenue. By the construction of this sewer, the sewage is kept from the beach and waters of the Aquatic Park at the foot of Polk and Larkin Streets.

Stanyan Street Sewer:

The old pipe sewer in Stanyan Street from Grattan Street to Frederick Street has been replaced by a 2-ft.x3-ft. reinforced concrete sewer, eggshaped with square top. The existing 3-ft.x5-ft. brick sewers in the crossings were utilized in the new sewer. Under this contract a 10-ft. taper and 921 feet of 2-ft.x3-ft. sewer were constructed.

Woolsey Street Sewer:

Sewerage facilities in the University Mound district were bettered by the extension of the main sewer in Woolsey Street from Dartmouth Street to University Street. 540 feet of 2-ft.x3-ft. reinforced concrete sewer and 47 feet of 18-in. ironstone pipe sewer were constructed at a cost of $5,503.50.

Third Street Outlet:

Due to the contemplated construction of the China Basin Terminal Warehouse of the Southern Pacific Company, it is necessary to extend the outlet of the present 3-ft.x5-ft. sewer in Third Street at the Channel, a distance of 185 feet southerly. A 2′ 6″ x 3′ 9″ reinforced concrete sewer on piles was contracted for at an estimated cost of $5,882.80 and construction has been practically completed.

Great Highway Sewer:

A contract has been awarded for the extension of the sewer in the Great Highway from Noriega Street southerly. Due to lack of funds, this contract calls only for 618 feet of 3′ x 4′ 6″ and 140 feet of 2′ 6″ x 3′ 9″ reinforced concrete sewer together with the necessary taper connection and manholes, but it is hoped that funds will be available during the new fiscal year to continue this sewer further.

Lake Street Storm Water Overflow:

An automatic relief gate for the outlet of the Lake Street sewer has been constructed. This gate, during dry periods, will seal the outlet so that no odors will escape and become a nuisance to the surrounding district, but will automatically open and release the storm water flow when necessary.

Sewer Drainage Maps and Underground Records:

The work of plotting records of sewers and underground structures, together with computations for all new installations, has been continued. The plotting of data in reference to all main sewers from available records was completed. A thorough study was made for a separate system of sewerage in the lower Sunset district, where the main storm sewer is not low enough to give sanitary sewerage service. Also the sewerage conditions of the Islais Creek and Army Street districts were investigated.

Proposed Sewers:

In the recommendations for budget appropriations for the fiscal year 1922-23, this Department requested the appropriation of $423,500 for the extension of main sewers. Of this amount $200,000 is estimated as the cost of constructing the **College Hill Tunnel Sewer,** $115,000 for the extension of the **Army Street Sewer** from its present termination to an outlet in Islais Creek near Mississippi Street; $23,000 for the **Sunnydale Avenue Sewer Extension;** $80,000 for the reconstruction of 1,500 feet of **sewer in Sixth Street** from Brannan Street to the Channel, and $5,500 for the replacement of the temporary wood pipe sewer now installed in **Tonquin Street (Marina Boulevard)** between Broderick and Divisadero Streets, by a permanent 2-ft.x3-ft. concrete sewer. The budget for 1922-23 as fixed by the Board of Supervisors has allowed $125,000 for the extension of main sewers, of which amount $100,000 is appropriated for the construction of the Army Street Sewer extension.

MISCELLANEOUS CONSTRUCTION.

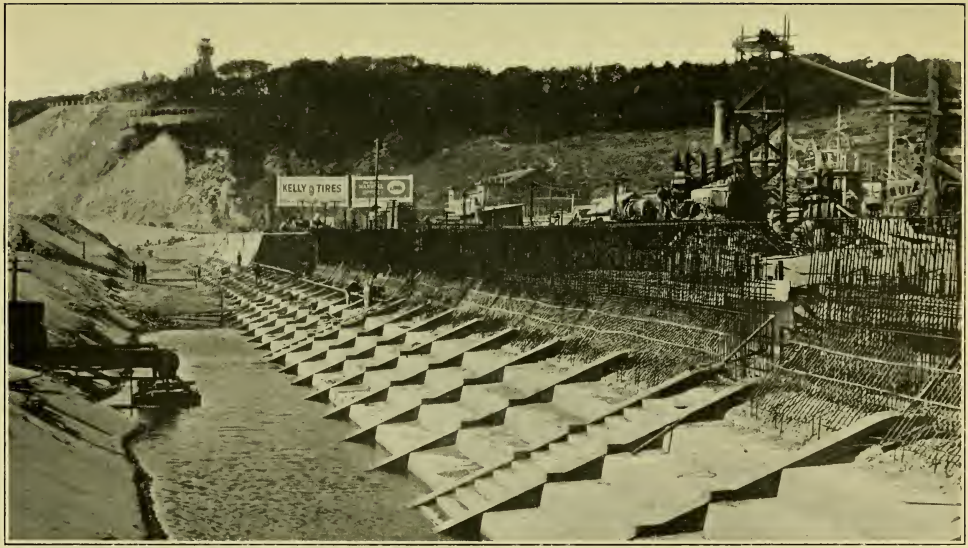
Aquatic Park:

Over 32,000 cubic yards of earth was moved in sloping off the Aquatic Park between Van Ness Avenue and Larkin Street, from Beach Street northerly to the Bay, and in the cut for the detour of the Belt Line Railway through this area. The reconstruction of the State Belt Line Railway trestle, removing it inshore from its previous location, and the spreading of ballast and ties for the new route of the railway around the curve of the Aquatic Park has been completed. The State Harbor Commission, under agreement with this office, has laid and ballasted the track over the new line and has removed the offshore trestle on the old route of the railroad. The old trestle not only interfered with aquatic sports but also presented an objectionable appearance. Any plan of realignment of the railway had to conform to the existing Belt Line tunnel under Fort Mason on the westerly border of Aquatic Park. As reconstructed, the tracks are placed in a shallow cut and as only a short piece of trestle is necessary at the tunnel approach, the new route will not detract from the use and beauty of the proposed park beach.

Following the grading of the Park and the completion of the railroad relocation, the Aquatic Park in the early part of 1922 was transferred to the jurisdiction of the Park Commission, which will be responsible for further improvements.

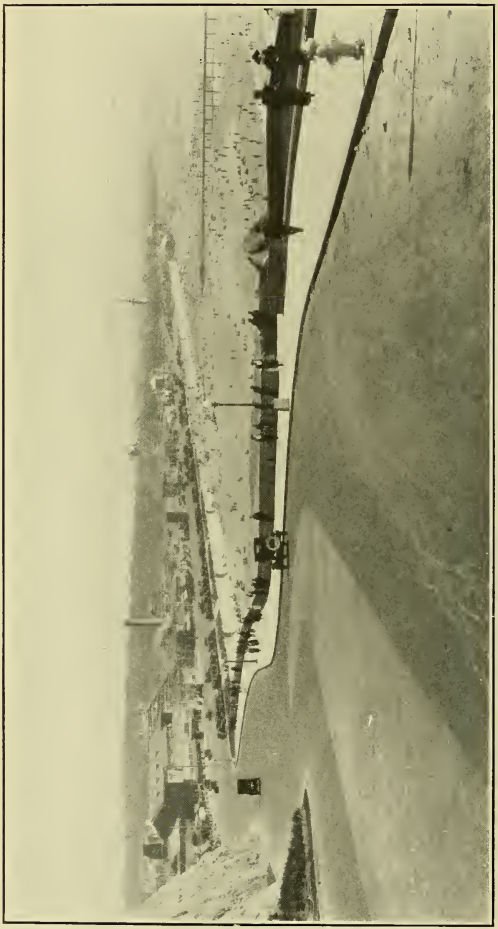
Esplanade:

A contract was awarded and construction has been under way for 1,070 lineal feet of Esplanade, known as Section "C" of this improvement, and extending southerly from the completed Esplanade. This section extends beyond and will protect the public underground comfort station erected recently on the Great Highway. The construction



OCEAN BEACH ESPLANADE

Showing different stages of construction—completed bleachers, reinforcement and forms for rollway and parapet, and completed section.



OCEAN BEACH ESPLANADE AND THE GREAT HIGHWAY
This construction will ultimately extend for three miles along the entire length of the Great Highway or ocean beach boulevard. (Point Lobos Avenue in the foreground.)

of this section of Esplanadé involved also a large concrete conduit to accommodate the intake pipes of the Olympic Salt Water Company and also the Trans-Pacific cable lines. When this section is completed there will be a total length of 1,740 feet of Esplanade completed.

In furtherance of the policy of this office to build a section of the Esplanade each year, the Board of Supervisors has been requested to include the sum of $150,000 in the new budget for the construction of Section "D" of the Esplanade.

Columbia Heights Fire Cistern:

A reinforced concrete cistern of 75,000 gallons capacity was constructed at the intersection of Lakeview and Josiah Avenues to provide fire protection for the surrounding Columbia Heights District. This district lacks the water supply and necessary pressure for fire fighting purposes. The cistern cost $6,885 and is of the standard type adopted by this department in previous years—30-foot interior diameter with vertical walls and spherical shaped dome and bottom. With the completion of this cistern there are now in use 142 cisterns, 86 of 75,000-gallon capacity and 56 of various capacities.

Street Signs:

Three hundred seventy-one street signs of the most modern pattern were erected at a cost of $7,000 in the downtown district, east of Van Ness Avenue and Eleventh Street and north of Townsend Street. These signs consist of four 5-in.x22-in. porcelain enamel plates, with 3-inch white lettering on a blue background, mounted in metal frames and erected on 3-inch standard pipe posts set in concrete, the signs being 9 feet above the sidewalk level. A study has been made for the systematic location of signs throughout the entire City and

STREET SIGN
Modern type of sign erected for marking the city streets.

a program of erecting signs will be followed as funds are available. With the appropriation of $7,500 which has been included in the budget for this year, it is planned to extend the signs to Divisadero Street on the west and Sixteenth Street on the South, and also to place signs along some of the most important thoroughfares outside of this district, such as Mission Street, Third Street, Lincoln Way, Fulton Street, Geary Street, etc. With an appropriation of $10,000 annually for the next two or three years, the streets of this City will be well marked, and then the cost of signs for new streets and for upkeep will be nominal.

Public Comfort Station:

There has been completed and put in use, at a cost of $32,966.13, a commodious, modern underground convenience station at the Ocean Beach Esplanade. This station, which has been fully described in a previous report, has been operating satisfactorily and will be a model for the many comfort stations which it will be necessary to construct in this City. An appropriation of $20,000 has been made in the Budget for the coming year for the construction of a convenience station which will be situated in the downtown business district.

Board Walk Along Great Highway:

Two thousand five hundred feet of Board Walk was constructed along the Upper Roadway of the Great Highway from Sloat Boulevard northerly. This marine driveway has been a popular "hike" for pedestrians, and to provide a walk free from the dangers of the congested highway, a walk 10 feet wide was constructed. This walk, as funds are provided, will be extended the full length of the Upper Roadway. In succeeding years, when the seawall will have been extended southerly, the temporary board walk will be replaced by the

more permanent type of walk and improvement constructed as part of the existing Esplanade.

Relief Home Tank:

A new 150,000-gallon wooden tank was constructed at the Relief Home and the old tank was repaired and put on a concrete foundation with the new tank, thus doubling the storage capacity for the water supply of the Home.

Proposed Work:

Public Comfort Station:—Plans and specifications for the construction of a public comfort station in the downtown shopping district have been under preparation. It is planned to construct a building above ground, preferably at the end of a blind alley in this district, and of neat but not ornate exterior design. The general interior fittings and finish are to be modeled after those of the public comfort station in service at the Ocean Beach Esplanade and which has been so favorably commented upon by authorities on sanitation. Some opposition to the establishment of such stations adjacent to retail stores and office buildings has been evident, but, since the abolition of saloons by the Volstead Act, comfort stations have become a vital need in the downtown district, and it is hoped that this selfish opposition will cease to delay those necessary improvements.

Evans Avenue Viaduct:—A concrete viaduct over the Ocean Shore tracks at Evans Avenue has been proposed for several years, but the completion of the improvement of Army Street from Third Street to De Haro Street has made the building of this structure more urgent. The development of the surrounding district for industrial sites is partly contingent on the construction of this viaduct. Provided the funds, which have been requested, are made available, construction will be started soon, as plans and specifications are prepared.

PROJECTS AND INVESTIGATIONS.

Rincon Hill:

The main features of the proposed grading of Rincon Hill have been described in previous annual reports. The report of the City Engineer recommending the regrade of Rincon Hill was submitted to the Board of Supervisors on June 13, 1921, and that body passed a resolution declaring its intention to order this work done. This report in detail covers the extent of the improvements recommended, the changes of grade that are to be made, together with the extent and boundaries of the district to be benefited by and assessed for this improvement. As a result of several public hearings held by the Board of Supervisors, further data was requested of this department, and this has since been placed before them. This data included the estimated costs of the completed project, also segregated estimates on cost of grading the streets and of grading private porperty, and of damages to private property and improvements, and also a complete assessment roll, showing the tentative assessment on each of the 4,854 parcels of land within the assessment district. Detailed plans for necessary alterations and additions to sewerage and high pressure systems and investigations of the extension of the spur track system into this district have been made.

Golden Gate Heights:

The lack of foresight shown by the early settlers in laying out the streets of this City on a rectangular plan has retarded the development of many sections of this City. The utter impossibility of grading and improving streets in their present location and grades in some of the hilly districts makes the property unfit for residential purposes without some radical change in the layout of streets. One of

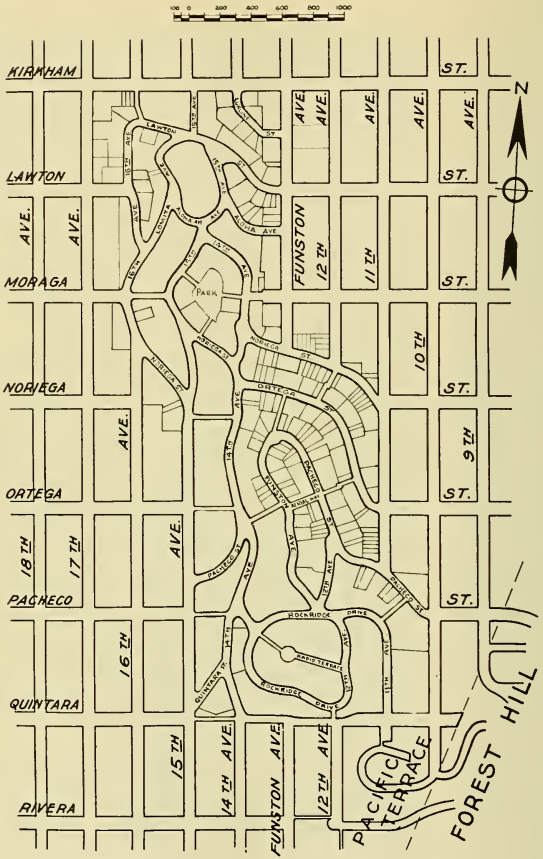
GOLDEN GATE HEIGHTS

Hillside district, unimproved due to heavy cut and impassable grades under present rectangular system of streets. Contour street system now being planned will solve this problem, increasing property values and beautifying the district.

these districts, which is now virgin, unsettled territory, is Golden Gate Heights, lying between Kirkham and Quintara Streets and Tenth and Seventeenth Avenues. The present official street grades range from 20 per cent to 43 per cent, and in order to grade these streets in their present locations, without increasing the above rates of grade, the necessary cuts would range from 21 to 92 feet. This Department is attempting to solve the defective planning of this portion of the city by a plan of contour streets which will provide easy grades and also reduce the cost per lot of the street improvements. The fact that there are but three buildings in the affected district has lessened the difficulties of the plan.

A meeting of the property owners was called by the City Engineer, the project explained to them, and they in turn appointed a committee to act with the City Engineer. The following method of procedure was adopted to carry through the undertaking—to secure the services of a guarantee and trust company to search and guarantee the title of all the property within the district; the property owners to deed their property in trust to said company; the City and County of San Francisco to deed all of present streets within the district to the trust company; the trust company then to deed back, first, to the City all the land necessary for the new contour streets; second, to the property owners, lots or parcels of land in new locations within the district, each lot or parcel to be equal in value and as near to the original holdings as possible.

This scheme does not include any outlay now for street work or construction of any kind, which will follow later (in the same manner as improvements in any other locality are now carried on) but at an estimated reduction of 60 per cent of the cost if done under present official grades in the objectionable rectangular block system. The present plan contemplates only improving the location of the streets and reducing the official grades. All necessary studies, sur-



GOLDEN GATE HEIGHTS

IMPROVED STREET PLAN

veys and maps have been made by this office without charge to the property owners, who have only been called upon to subscribe 1 2-3 mills per square foot of property, or $5 per lot of 25 feet by 120 feet in size. This would raise a fund of about $6,000 which will pay the fee of the trust company and incidental expenses. Nearly every property owner in the district has agreed to this plan and paid his pro rata. Over 95 per cent of the necessary deeds to private property have been given to the trust company selected to handle the details. The remaining 5 per cent represents mostly owners who are or have been out of town and could not be reached. These, it is hoped, will soon accept the plan and place their deeds with the trust company. When this is done, the City will release its title to the public streets and the deeds to the new parcels will be given to the owners and the new streets dedicated. Meanwhile the necessary documents are being prepared—deeds, mortgage releases and new mortgages—so that the actual change of property ownership can be accomplished rapidly, following the entrance of the few delinquent owners into the scheme.

Ingleside Heights:

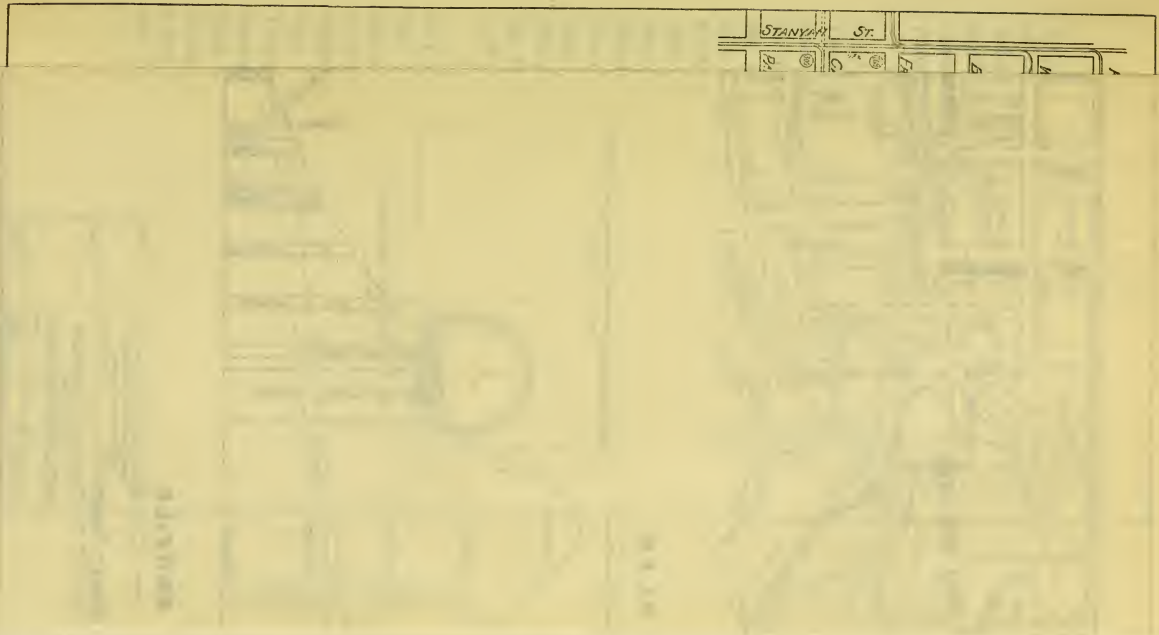
This Department has proposed a resubdivision of the property now commonly known as Ingleside Heights, comprising the greater portion of the City Land Association Subdivision and the adjoining westerly portion of the Railroad Homestead Association Subdivision, south of Ingleside Terrace. This district, lying between Garfield and Randolph Streets and Junipero Serra Boulevard and Faxon Avenue produced, presents a similar problem to that of Golden Gate Heights and the solution suggested is along the same lines as that being undertaken for the latter district. Although this property is located on the hillsides, the original subdivision was made on the gridiron system of rectangular blocks. The present official grades range from 10 to 40 per

cent, and were the streets to be improved along the present lines and grades, many of them could not be used for vehicular travel, and even with these steep grades, heavy cuts would be necessary, leaving the property on a bank above the street. In consequence, the cost of the street improvement would be high, and the value of the property low. The plan proposed by this department requires the co-operation of every owner of property in the district. The property owners will meet only the expense of the title insurance and trust company, which will not exceed $5 per 25-foot lot.

Included in the district are 5½ miles of streets and 1,630 parcels of land, 145 lots of which are built upon, thus adding to the difficulties of resubdivision with minimum damage to improvements. Of the 669 owners of property in the district, 30 per cent are non-resident. All the owners have been communicated with and favorable answers received from about 40 per cent of them. A meeting has been held at which the plan was explained to the owners present and a chairman and secretary elected to represent the owners and work with this department for the ultimate realization of the resubdivision. Meanwhile the property owners who have not responded are being sought out and their consent to the proposed plan obtained.

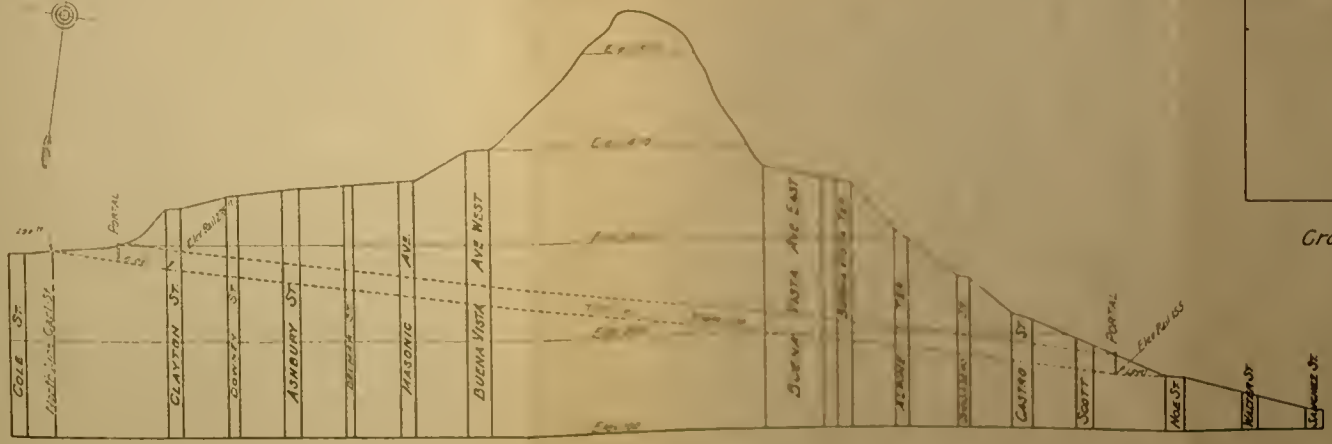
Sunset Tunnel:

After study and investigation of various routes proposed for tunnel construction to the Sunset district by the City Engineer, the Board of Supervisors finally requested a report giving data in connection with the most favored route, viz., from Duboce Avenue and Scott Street under Buena Vista Park to the neighborhood of Cole and Carl Streets. The first step was taken by this office in answer to the above request in the form of a preliminary report to the Board of Supervisors, and presented to them on May 31, 1922. This report in a general way covers a description of the proposed construction, and the points to


STANYAN
ST.

PLAN

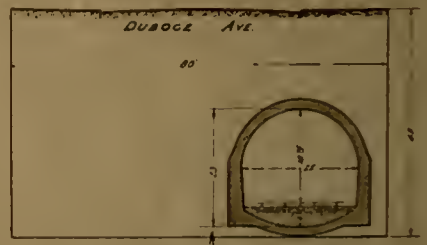
Scale 1" = 400'



PROFILE

Scale 1" = 400' Horiz.
1" = 40' Vert.

SUNSET TUNNEL
4731.565 Feet Portal to Portal



Cross-Section A-B
Scale 1/8" = 1 ft.

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING

SUNSET TUNNEL

PLAN, PROFILE AND CROSS SECTION SHOWING THE GRADIENTS OF TUNNEL AND APPROACHES

be connected thereby. There was also given a description of the boundaries of the proposed assessment district which would be benefited by this tunnel, and a description of such lands and rights of way necessary to be acquired. A plan showing the outline of the assessment district also accompanied the report.

The Sunset Tunnel will open up a section of the Sunset district directly south of Golden Gate Park, approximating 1,200 acres, which will provide room for at least 50,000 additional people in San Francisco. By comparison with the rapidly growing Richmond district, it is quite evident that the Sunset district has suffered materially from lack of direct, efficient transportation service, and removal of these hindrances will undoubtedly open up a new era for this section of the City. At the present time the only railway service that this section of the City receives is by way of Haight Street over a circuitous route up and down many steep grades, and through the narrow neck between Golden Gate Park and Sutro Forest by way of Parnassus Avenue or Frederick Street. Considerable time is consumed in traveling this route. The only practical relief for this condition is the building of the Sunset Tunnel.

The Sunset Tunnel will begin at Duboce Park adjacent to Duboce Avenue and Scott Street, and will extend under the elevation upon which is situated Buena Vista Park, a distance of 4,230 feet from portal to portal, to a point close to Cole and Carl Streets. It will be a double track structure about 25 feet wide and 18 feet 9 inches high, resembling very closely the appearance of the present Twin Peaks Tunnel. The grade through this tunnel will be 3 per cent ascending toward the Cole and Carl Street portal, a very light grade, especially in contrast with the present heavy grades on the Haight Street lines. In time alone there will be a saving of at least 10 minutes between Cole and Carl Streets and Third and Market Streets.

DISTRICT AROUND WESTERLY PORTAL OF TWIN PEAKS TUNNEL IN 1917
This view was taken following the completion of the tunnel before car service was established.
Compare with the following view of same district in 1921.

HOME BUILDING IN DISTRICT AROUND WESTERLY PORTAL OF TWIN PEAKS TUNNEL IN 1921
This view shows the result of rapid and efficient transportation service.

Although actual borings will be taken to determine the exact nature of the material through which the tunnel will pass, all surface indications point to a good hard sandstone formation for the major portion of the tunnel. It will take about 18 months actual construction to complete the tunnel.

The assessment district outlined approximates about 1,140 acres, and the assessments will be very nominal. They will be made on a sliding scale, the maximum being against that property which borders directly on the new project and which will be more directly benefited, the lower rates applying to the outskirts of the assessment district. Assessments will be arranged to extend over a period of 10 years, if desirable, during which time the properties benefited will greatly appreciate in value.

It is only necessary to look at the marked development of the large acreage directly southwest of Twin Peaks resulting from the construction of the Twin Peaks Tunnel to enable one to properly visualize what the future holds in store for the Sunset district upon the completion of this meritorious project.

On May 31, 1922, the Board of Supervisors passed a Resolution of Intention wherein they declared their intention of constructing the tunnel along the lines above mentioned. Notices in accordance with the Tunnel Procedure Ordinance are now being posted notifying all parties concerned of such intention.

Surveys have also been made of the lands that may be necessary for the tunnel construction. This Department is now preparing, under instructions from the Board of Supervisors, a complete report covering the actual assessment on each parcel of land benefited, the damages as a result of tunnel construction, complete plans and specifications for the construction, and estimates of the cost of the same.

San Francisco Bay Bridges:

This Department prepared maps, secured data and made preliminary locations for a proposed bridge across San Francisco Bay at Dumbarton Point. Such data have been in the hands of the Boards of Supervisors of San Francisco County and San Mateo County, and, as a result of many hearings, the Boards have passed resolutions favoring the formation of a joint highway district, having in view not only the construction of a bridge at or near Dumbarton Point, but also the construction of an additional highway 125 feet wide through San Francisco and San Mateo counties leading to the bridge approach.

At hearings on the San Francisco-Oakland Bay Bridge project held during the month of October, 1921, by the United States Government in San Francisco, maps and various data directly bearing on the project were displayed by this Department.

Van Ness Avenue Extension:

Among the major projects that have been considered by this department for future realization may be mentioned the extension of Van Ness Avenue. The plan, as prepared, calls for the extension of Van Ness Avenue southerly across Market Street, crossing Mission Street, and continuing to a junction with Thirteenth and Howard Streets. This is the only logical extension of Van Ness Avenue to make, and, if made, will form a trunk line which eventually will be the outlet for the greater part of the traffic southerly to the Peninsular highways. The new street as proposed would be 125 feet wide and 1,200 feet long. At this time the necessary information is being secured, preparatory to the Board of Supervisors declaring a Resolution of Intention to create such extension.

Islais Creek District Industrial Sites:

Replotting and mapping of the Islais Creek district, bordering on Napoleon Street, San Bruno Avenue and Oakdale Avenue, west of the present Southern Pacific trestle, has been under consideration. Quantities have been computed and costs estimated of the work necessary to make this district suitable for industrial sites. Following along the plans proposed, several streets, which divided the district into small blocks, have been closed, thus providing spacious undivided sites necessary for industrial plants. Other subdivision will be undertaken so as to allow of spur track facilities to all the holdings, which will make them most attractive to large industries.

Miscellaneous Studies and Investigations:

The following subjects are a few among the many studies and investigations upon which this Department has been engaged:

Centralization of material storage with up-to-date bunkering methods at the Corporation Yards for the Departments of Street Repair and Street Cleaning.

Location of a stadium on properties bounded by Frederick, Willard and Stanyan Streets, and Golden Gate Park.

The study of traffic conditions on Waller Street in connection with the closing of that street between Buchanan and Laguna Streets.

The improvement of Sutro Heights, the Park recently donated to the City by Mrs. Dr. Merritt, daughter of the late Mayor Sutro.

Traffic conditions in the business sections of the City, which involved actual traffic counts.

SURVEYS

Surveys Performed

Made for—	1920-21		1921-22	
Public Contracts	46		110	
Private Contracts	111		175	
Resurveys for Contracts (lost points)	30		56	
Municipal Departments	221		103	
Total for Public Improvements, etc.		408		444
Lot Surveys—Private Owners	41		65	
Municipal Department	16		22	
Total Lot Surveys		57		87
Total Surveys		465		531

Surveys include approximately:

1920-21, 1130 blocks and crossings, total length 439,450 feet=83 miles.
1921-22, 1366 blocks and crossings, total length 345,000 feet=65 miles.

Precise Levels and Bench Marks

	1920-21	1921-22
50 Vara District	332	294
100 " "	165	83
Mission	107	92
Horner's Addition	410	63
Richmond District	139	46
Sunset "	186	31
Potrero and South San Francisco	350	139
Western Addition	93	1,080
Other Districts	798	572
Total Bench Marks	2,580	2,400
Precise Levels—Total Miles	113.63	87.50

Maps Approved and Filed with the Recorder

Date Recorded.	
July 27, 1920	Harder and Daniels Mission Tract (2nd map).
Sept. 8, 1920	Balboa Terrace.
Oct. 14, 1920	Sutro Properties—Land deeded by George and Emma Merritt to the City and County of San Francisco.
Nov. 26, 1920	San Bruno Ave.—Straightening at Flower St.
Mar. 3, 1921	Hampshire St., 25th to Army St.
July 28, 1921	Army St. Widening, San Bruno Ave.-Holladay Ave.
Aug. 10, 1921	Army St. Widening, Third St. to De Haro St.
Sept. 6, 1921	Louisburg St. Widening. Niagara Ave. to Geneva Ave.
Sept. 17, 1921	Merrie Way, Northerly from Pt. Lobos Ave. West of 48th Ave.

Maps Approved and Filed with the Recorder—Continued

Oct. 4, 1921	Douglas St. Widening, 21st St. to Romain St.
Dec. 10, 1921	Camino Del Mar, 27th Ave. Westerly.
Dec. 22, 1921	Kenny Alley, London St.-Mission St.
Jan. 27, 1922	30th Ave. extended and Lake St. extended.
Jan. 27, 1922	Morse St. Widening at Guttenberg St.
Mar. 3, 1922	Camino Del Mar, East of 25th Ave.
April 3, 1922	Villamar Ave.
June 19, 1922	Hemminga Subdivision.

Fees Received for Surveys

	1920-21	1921-22
July	$ 260.00	$ 894.25
August	313.75	703.75
September	976.50	198.00
October	107.00	235.00
November	397.00	1,362.55
December	147.00	679.85
January	229.60	1,189.50
February	538.50	368.65
March	459.60	1,063.00
April	386.00	542.50
May	282.50	1,449.25
June	345.00	685.00
Totals	$4,442.45	$9,371.30

Fees Received for Inspection

	1920-21	1921-22
July	$ 1,503.00	$ 409.50
August	2,304.50	342.00
September	2,152.00	1,769.00
October	2,425.00	706.50
November	2,149.50	1,858.50
December	393.75	997.50
January	831.00	490.50
February	808.00	589.50
March	1,636.00	108.00
April	724.50	1,926.00
May	486.00	1,062.00
June	1,516.50	1,935.00
Totals	$16,929.75	$12,194.00

Grand Total Fees for Surveys and Inspection, 1920-21 ..... $21,372.20

Grand Total Fees for Surveys and Inspection, 1921-22 ..... $21,565.30

STREET IMPROVEMENT ASSESSMENTS, ETC.

	Fiscal Year 1920-21	Fiscal Year 1921-22
Assessments and Bonds for Street Work—		
Assessments issued for cost of work performed	55	37
Cost of street improvement covered by assessments	$514,701.77	$357,849.07
Bonds prepared (in triplicate)	157	105
Amount of assessments guaranteed by bonds	$ 31,644.34	$ 54,029.09
Average amount guaranteed by each bond	$ 201.55	$ 514.56
Street Work Proceedings—		
Resolutions of Intention passed	55	57
Street improvements recommended under Resolutions of Intention	85	107
Notices of Street improvement posted	1,477	1,695
Notices of Resolutions of Intention mailed	2,074	3,707
Ordinances ordering performance of street improvement passed	52	66
Proposals of street improvement published	47	90
Public contracts for street improvements awarded	39	72
Private contracts filed	62	97
Notices, Permits and Investigations—		
Notice to construct and repair sidewalks	1,133	1,167
Notice to construct bulkheads	357	409
Notice to remove obstructions	503	381
Notice to construct guard rails	16	
Notice to reconstruct side sewers	55	489
Street space permits examined	1,620	1,783
House moving permits reported on	27	33
Miscellaneous calls and investigations	1,719	1,911

Permits and Fees for Corporation Trenches, Etc.

(In conformity with Ordinance 2201)

Corporation	Permits Issued 1920-21	Permits Issued 1921-22	Mains Installed Lineal Feet 1920-21	Mains Installed Lineal Feet 1921-22	Fees Charged 1920-21	Fees Charged 1921-22
Pacific Gas & Electric Co.	3,386	3,810	61,754	15,410	$ 5,128.50	$ 5,859.75
Spring Valley Water Co.	3,399	4,029	1,423	7,005	4,410.75	6,051.75
Great Western Power Co.	54	57	1,020	3,316	81.00	106.50
Pacific Tel. & Tel. Co.	91	135	4,305	13,906	149.00	297.00
Universal Electric & Gas Co.	44	9	1,255	.....	63.50	13.50
Western Union Telegraph Co.	5	1	.....	.....	5.50	1.50
*Miscellaneous under Special Deposits	246	570	.....	.....	672.00	1,945.50
Total for which fees were charged	7,236	8,611	69,757	39,637	$10,510.25	$14,275.50
Total for which no fees were charged	958	1,586				
Total permits	8,194	10,197				

*Permits granted for which special deposits were made to move steam shovels and tractors, to repair or install oil tanks, service pipes, fire alarm wires, cables and conduits, to lower curbs, etc.

MUNICIPAL RAILWAYS.

Market Street Railway Purchase:

In November, 1920, a charter amendment was carried, making it possible to purchase public utility properties out of their earnings. Immediately after the passage of this charter amendment agitation by various civic groups was commenced for the purchase of the properties of the United Railroads of San Francisco. In April, 1921, the Board of Supervisors passed a resolution directing the City Engineer to make a valuation of the properties of this company and to report his findings and conclusions bearing on the purchase of the property.

The United Railroads had previously made application to the State Railroad Commission for permission to reorganize and refinance. This permission was granted and on the first of April the name of the Company was changed to the Market Street Railway Company, with a capitalization of $47,516,000, divided as follows:

5 per cent bonds due September 1, 1924	$10,166,000
6 per cent notes due September 1, 1924	5,200,000
6 per cent prior preference stock	11,750,000
6 per cent preferred stock	5,000,000
6 per cent second preferred stock	4,700,000
Common stock	10,700,000

Commencing in June, 1921, a force was employed by this department to make a valuation of the physical property of the company. This work was so far completed on September 10th as to permit of making a report to the Mayor and the Board of Supervisors. The detailed inventory and appraisal was completely assembled by January, 1922, and is in four volumes, containing 2670 pages, with many drawings and photographs.

A special committee, consisting of His Honor the Mayor, the City Engineer, the Chairman of the Finance Committee of the Board of Supervisors, and the members of the Public Utilities committees of that body, was appointed to consider the purchase plan. Numerous meetings have been held, some of which were attended by the officials of the corporation. Two objects were to be accomplished by the committee: First, the arrival at a price satisfactory to both the City and the Company; second, the determination of the manner in which the purchase should be financed. At the end of the year there is nothing definite which can be reported as the outcome of the deliberations of this committee.

Following is a copy of the City Engineer's report of September 10th to the Mayor and the Board of Supervisors, and also a statement of the division of values between the various classes of construction.

City and County of San Francisco, Department of Public Works, Bureau of Engineering.

September 10, 1921.

Honorable James Rolph, Jr., Mayor, and Board of Supervisors,
City and County of San Francisco.

Dear Sirs:

In response to your Resolution No. 18819 (New Series), directing me to make an appraisal of the value of the properties of the United Railroads, and when made to report to the Board, as fully as possible, my findings and conclusions, in accordance with the provisions of Charter Amendment No. 30, adopted November 2, 1920, I beg herewith to submit my report on the United Railroads properties, now called the Market Street Railway Company.

Through the courtesy of the Railroad Commission of the State of California, and its chief engineer, Mr. Richard

Sachse, Mr. R. C. Ashworth, assistant engineer of the Commission, was permitted to assist in this office Mr. P. J. Ost, the railroad and electrical engineer of this department, in preparing this valuation.

Physical Properties. A complete inventory has been made of all the physical properties of this company in San Francisco and San Mateo counties. This portion of the work has been materially facilitated by an inventory compiled jointly by the Market Street Railway Company and the Railroad Commission of California, who on Application No. 5840 rendered a decision (No. 8482) December 22, 1920, on the value of the property for purposes of reorganization. A complete copy of this inventory was made embracing over 40,000 sheets, corrected to date, properly indexed, and placed in the files of this office.

Value Determination. The values of labor and materials at the present time are above normal and are on a descending scale. A five-year period was selected, from 1913 to 1917, inclusive, as one of the average five-year price periods of the past to represent the anticipated prices that may probably prevail in the future. Units of value for this period were determined in arriving at the total values, and the result obtained represents the reproduction cost new of this property as being $35,300,000.

A field survey of all track, equipment, car buildings, power-houses, land holdings, etc., was made, and the physical condition of each portion of the properties noted and the depreciation computed for same. This condition was determined on the basis of the fair value of the property to the city in the future operation of the railroads. The aggregate of the depreciation on all of the properties amounts to $8,900,000. By deducting this depreciation from the reproduction cost new, the present value of the physical properties was determined as being $26,400,000. This is exclusive of

any allowance for going concern, development or any other intangible values; in other words, it represents the "bare bones" of the property on the basis described.

It is of interest to note that in the valuations made by the Railroad Commission and the Market Street Railway Company the depreciated physical valuation determined by the former was $41,424,961, and by the company's engineers $52,210,195. It will be noted that the valuation prepared by me is approximately $15,000,000 below that of the Railroad Commission and $25,000,000 below that of the company. It should be borne in mind, however, that the Railroad Commission and the company each used as a base for obtaining prices the three years of 1918, 1919 and 1920, when prices of labor and materials were at a maximum. The valuation of the Railroad Commission, however, was consistent at that particular time, as it represented the true value of the properties at the date the reorganization was made.

From a comparison of these data, it appears that the reproduction cost new less depreciation of the physical property will vary from a maximum of between $41,400,000 and $52,200,000 to a minimum of $26,400,000, this determination, as above pointed out, being derived from the application of prices current over a period of five years preceding our entry into the European war. In my judgment, it is conservative to state that the reproduction cost new less depreciation of this property as of today cannot be less than $35,000,000.

On March 4, 1918, I made a report to your Board on the principles of valuation which I deemed to be fair for the acquisition of these properties by the City and County of San Francisco. This sale price, agreed on at that time between the United Railroads and the City, comprised two items—first, the physical value of the properties; secondly, the probable net earnings during the remaining franchise

life of the different lines of track comprising the property. These franchises expire at different times from 1929 to 1945 and various estimates have been made of the profits from ownership during that period. Those estimates range all the way from $35,000,000 to $50,000,000 in case the properties remain in the possession of the Market Street Railway Company. Those estimates of profits are, however, to a large extent speculative, based on contingent conditions which it is very difficult to forecast accurately.

It is not possible to determine accurately these future earnings nor does it seem necessary to do so at this time, though it is evident that on any basis the amount is large.

Taking into consideration all of the elements which enter into the problem I have determined that the fair price which the City should pay for all of the properties of the Company, including the lines in both San Francisco and San Mateo counties, and including both the physical property and the future earnings, is the sum of $40,000,000. This would give the City of San Francisco a unified ownership of all of the transportation systems of San Francisco, except the California street cable system.

The following economies will be obtained by municipal ownership:

Yearly saving in taxes	$ 551,000
Damages in operation reduced by automobile and jitney regulation	50,000
Adjustment of Market Street Railway power contract	350,000
Adjustment of car schedules with non-competitive conditions	500,000
Combination of work in shops, etc.	70,000
Elimination of Presidents and Directors and legal expenses	275,000
Increase in receipts from elimination of competitive jitney operation	500,000
	$2,296,000

City Ownership Extra Expenses: The Municipal Railways are now paying a greater wage to its employees than

the private company. The people of San Francisco recognize the fact that living conditions in the City are expensive and that its employees must have a generous wage so that they can live and bring up their families in conditions of comparative comfort.

The Market Street Railway Company has 2,800 employees at the present time, working on a wage scale lower than the City pays. I have made a careful computation of the annual increase of wages to be incurred by placing those men, including platform, track, electrical, line, shops, general superintendent, motive power, electric and cable superintendent of transportation and other employees on the municipal scale. This added expense would amount to $1,718,000.

By deducting this from the savings by unified operation, an annual increase of $578,000 in net earnings can be made. This amount, with the net income from operation, would at present more than meet interest at 5 per cent on the $40,000,000 valuation which I place on the property. If the unified holding is conducted as economically and safely as the Municipal Railway has heretofore been operated, there is no doubt that the proposed purchase will be an advantage to the City.

Universal transfers could be adopted, which would promote more car riding and increase revenues, and besides be a great convenience to the public in saving time in making trips from different portions of the City now served by the two lines. Conditions on Market street could be improved by restricting rapid transit to the center tracks, with a longer distance between stops, and confining the service to cars for the outside districts. The outer tracks on Market street would be used for local, shorter hauls and frequent stops would be made with greater safety and convenience to the public. Economies could be effected by

discontinuing unnecessary car lines, as many of those now operated by the company are due to franchise requirements. New extensions of track could be made into districts now without service, due to dual ownership, which has heretofore restricted extensions.

The jitneys should be absolutely forbidden to travel on streets now served by cars, as it is an economic waste to have a dual service for the same object.

The success of the unified ownership would, however, depend on conducting the system on the same high ideals and good business principles which have controlled the operation of the Municipal Railways in the past nine years.

I cannot close this report without returning thanks for the conscientious and energetic assistance rendered by Messrs. Ost and Ashworth and the men employed under them, who very often worked nights and overtime in order to get this report ready.

Very respectfully,

M. M. O'SHAUGHNESSY,
City Engineer.

The properties to be purchased include the physical properties owned by the Market Street Railway Company, Gough Street Railroad Company, Sutter Street Railway Company, and the South San Francisco Railway & Power Company, and consist of 225 miles of electric main line tracks and 19 miles of electric connecting tracks, yard tracks, car house tracks, and spurs; 15 miles of cable tracks together with 1 mile of cable tracks in car houses, etc., all in San Francisco County. In San Mateo County 33 miles of main line electric tracks and 1 mile of other tracks—a total of 294 miles of track in the system.

Lands consist of 14 acres of right of way and 57 acres of other lands used for car barns, yards, substations, and

other purposes, in San Francisco County, and 60 acres of right of way and 1 acre of other land used for substation purposes in San Mateo County.

There are 31 locations in San Mateo County where stations and waiting rooms are located and 19 in San Francisco County. There are 17 locations in San Francisco County used for shops and car houses and 22 locations where miscellaneous buildings are located.

There are 6 substations for power supply, 5 located in San Francisco County and 1 in San Mateo County. The cable lines are driven from 3 power houses.

The rolling stock consists of 796 passenger cars and 81 miscellaneous service equipments.

Statement of Market Street Railways Valuation.

	Reproduction Cost	Reproduction Cost, Less Depreciation
Land, right of way, buildings	$ 3,649,003	$ 3,237,713
Road accounts	18,000,275	13,494,291
Equipment	8,044,958	5,496,010
Miscellaneous, engineering, overhead	5,579,206	4,138,352
Total	$35,273,442	$26,366,366

Extensions:

Preliminary studies and reports were made on a variety of projects for extensions and improvements to the Municipal Railway system, and contracts were awarded for the most urgent items only. The lack of adequate funds from which to make extensions, and the uncertain status of the proposed Market Street Railway system purchase, forbids commitments to undesirable and hastily considered undertakings.

With the acquisition by the City of the Market Street Railway system, operating conditions would be materially

changed. No program of extension should be undertaken which will not fit in with the unified ownership and operation of the two systems until it is definitely known whether or not the corporation lines are to be acquired at an early date. Notwithstanding these existing conditions this department has been besieged with requests for railway extensions into almost every quarter of the City. Formal reports were requested by the Board of Supervisors on five extensions, only one of which, the Taraval Street line, has been ordered constructed.

The problems reported on, with a brief statement of each, follow:

Sunset District Line: In considering this line the problem to be solved is that of giving the residents of the Sunset District quick and direct transportation to and from the downtown section of the city. Studies of various routes have resulted in the recommendation of the Duboce Avenue route as offering the best solution of this problem, and as fitting in admirably with the proposed unified operation of the Municipal and Market Street Railway systems.

This line would extend from Market westerly on Duboce Avenue to the southwest corner of Duboce Park, thence via a tunnel under Buena Vista Park to Cole and Carl Streets, thence on Carl Street, Ninth Avenue and Judah Street to the Great Highway. The new construction would comprise about 4.54 miles of double track and about 4,300 feet of tunnel. The total estimated cost of the project is $2,467,000, of which the tunnel is estimated at $1,650,000. The running time via this route from the Ferry to the Beach would be approximately 39 minutes. It is proposed that the property benefited be assessed to pay for the construction of the tunnel.

Masonic Avenue Line: This line, as contemplated would run from the end of the present Municipal track at Masonic Avenue and Turk Street,

via Masonic Avenue, Waller, Cole and Seventeenth Streets, to Stanyan Street. Portions of this route would operate over tracks of the Market Street Railway, necessitating some traffic agreement.

This route has been urged as a solution of the traffic problems of the district southeast of Golden Gate Park, but aside from a limited utility as a crosstown line, the advantage of the extension is not apparent. Before reaching the Geary Street lines, to which it is proposed to transfer the passengers, the extension would cross seven routes of the Market Street Railway, all of them carrying less traffic than is now carried on Geary Street. Thus, it would not be necessary under unified operation, and at the same time it encroaches on the carrying capacity of Geary Street, which, with the coming growth of the Richmond District, is very undesirable. In peak periods there is over a car to the minute operated on Geary Street at present. It would, therefore, be an absurd solution of relieving transit conditions in the Panhandle and Sunset districts to dump more cars from these sections into Geary Street.

Ocean View Line: This proposed extension would render service through the Twin Peaks tunnel, to the residents of the Ocean View district. Two alternative routes have been proposed, one via Junipero Serra Boulevard, and the other from the present terminus of the "K" line at Brighton and Grafton Avenues southerly into the district. A preliminary survey and report covering the latter route has been made. The steep grades render it impracticable to follow the streets, and the survey has been run on grades not exceeding 8 per cent, to develop a line fitting the topography and disregarding street lines. The proposed construction would be very expensive, requiring heavy grading and the construction of retaining walls, as well as the purchase of private right of way. The cost of this extension, comprising about two-thirds of a mile of double track, has been estimated at $240,000.

The Boulevard route through the Spring Valley property would have value as a new trunk rapid transit artery to San Mateo, from which a branch would lead to Ocean View.

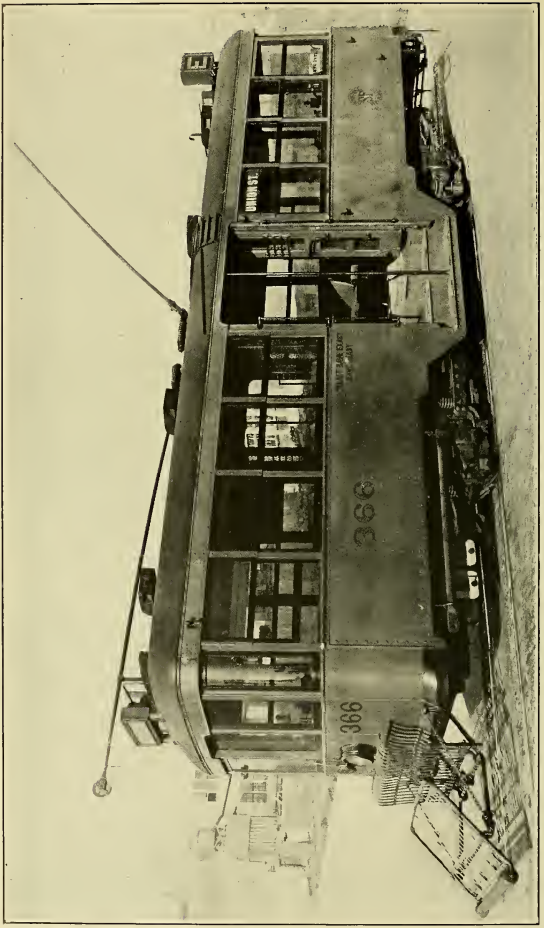
Embarcadero Bus Line: To take care of traffic along the Embarcadero it has been proposed to establish a bus line running from Third and Townsend Streets to the foot of Van Ness Avenue. This proposal has been studied at various times for several years, the first report of this office being made to the Public Utilities Committee on Jan. 3, 1917. Although this line would be a convenience, it could not be operated except at a heavy annual loss, and on operating and financial grounds this department reported unfavorably on its establishment by the City.

Taraval Street Extension: To carry out the City's obligation to those property owners of the lower Sunset District who paid assessments for the Twin Peaks tunnel, averaging over $50 on each 25-foot lot, the extension of the Taraval Street line, from Thirty-third Avenue to the Great Highway was undertaken and will be completed this summer. This line will connect Market street, via the Twin Peaks tunnel, with the lower part of the ocean beach, and is one which will be of service under any unified plan.

A contract covering the grading and track construction was let and is now well under way. Another contract for installing 91 concrete poles, 9,400 feet of trolley wire and 6,000 feet of feeder cable for this extension, is now nearly completed. Practically all the materials for this work were procured by the City under separate contracts.

Congestion on Market Street:

The congestion on lower Market Street during rush hours has led to a study of some means of reducing the number of cars running to the Ferries and yet more adequately taking care of the traffic from the down-



CENTER ENTRANCE CAR
Municipal Railway of San Francisco.

town shopping district. The most satisfactory immediate solution of the problem is the installation of a branch-off at Grant Avenue, which would enable east-bound cars to loop via Grant Avenue, Geary and Stockton Streets, back into Market Street west-bound. Preliminary steps have been taken to install the necessary track work for putting this service in operation.

Equipment:

The last cars purchased for the Municipal Railway were received in 1914, at which time 125 cars were bought under the 1913 bond issue. It is now necessary to place all of our present equipment in service during the rush hours, allowing no spare cars with which to expand the service as occasion demands. Plans and specifications are almost complete covering the purchase of twenty or more double-truck cars of the same type as those in general use on our lines.

The age of the cars purchased with the Union Street Line made it desirable not only from the standpoint of service, but also in the interest of economy, to replace this equipment. Contracts have been awarded for twenty central entrance cars suitable for use on the Union Street Line. A car of the proposed design was built and tried out in actual service, proving so satisfactory that the design was adopted practically without change, and the plans and specifications for this contract prepared accordingly. Each car is fitted with two 50-horse-power motors, and mounted on a single Brill "Radiax" truck, with 12-foot wheelbase and 26-inch wheels. Both wheel and track brakes are used, operated either by hand or by air. The car weighs about 13 tons, and will seat 32 people.

The contract is divided into four sections, "A", "B", "C" and "D", covering the construction of the bodies and the furnishing of the trucks, motor equipment and air brake equipment. Deliveries are expected early in September. The total cost of each car will be approximately $10,000.

Contracts:

In all, eleven contracts for the Municipal Railway system, with appropriations aggregating $380,000, were let, all during the last fiscal year as no work was undertaken during the fiscal year 1920-21. There being no other funds available, all the work is being financed out of the Depreciation Fund of the Municipal Railways.

A list of the contracts awarded or under way is part of the current contract data included in this report.

Lo

Ma
C
Eva
Gre
Li
Slo
G
Gre
B
Mar
Div
Lag
L
Ply
L
Pt.
Lon
Gen
Cas
San
Ball
Lib
Lea
M
Gre
C
Mar
Can
Can
Bea
Sta
Wo
D
Thi
Gre
Lak

etchy
rated
mong
g up
rials,
nnel
t has
oses:
educt
casin
unit
etion
gton,
con-
oring
the
and
owed,
from
will
reas-
casin
the
occa-
peed.
reek
ower
ulgas
ween

Contract
*Balance

CURRENT CONTRACT DATA, 1920-1921 and 1921-1922

LOCATION	CONTRACTOR	Date of Award	Date Completed	Per cent Completed to June 30, 1922	Amount of completed contract	Amount of City Funds Expended on Contract to June 30, 1921	Amount of City Funds Expended on Contract to June 30, 1922	FUNDS
Boulevards—Paving and Grading								
Market St. Extension, Colliagwood St. to Ord St.	Raisch Improvement Co.	1 9 20	10/ 1/20	100	$ 37,606.73	$37,606.73	Completed in previous year	County Roads
Evans Ave., Napoleon St. to Army St.	J. P. Holland	1/23/20	10/19/21	100	19,999.54	9,370.80	$ 17,499.54*	County Roads, General Fund and Private Contribution
Great Highway, E. ½, Lincoln Way to Fulton St.	Raisch Improvement Co.	5 21 20	11/10/20	100	38,267.51	38,267.51	Completed in previous year	County Roads
Sloat Boulevard, N. ½, Great Highway to 35th Ave.	The Fay Improvement Co.	6 4/20	12/ 1/20	100	40,133.69	40,133.69	Completed in previous year	County Roads
Great Highway, W. ½, Balboa St. to Cabrillo St.	Raisch Improvement Co.	7 2/20	1/12/21	100	11,881.17	11,881.17	Completed in previous year	County Roads
Market St. Extension, Mono St. to 24th St.	Schultz Construction Co.	9/17/20	9/14/21	100	103,714.76	91,102.90	103,714.76	County Roads
Divisadero St., Haight St. to Clay St.	E. J. Treacy	11/19/21	5/12/22	100	31,563.70		13,800.00	General Fund and Property Owners
Laguna Honda Boulevard, Lawton St. to Woodside Ave.	The Fay Improvement Co.	12/10/20	6/ 8/21	100	35,050.63	31,000.00*	Completed in previous year	County Roads
Plymouth Ave., Lakeview Ave. to Farallones St.	The Fay Improvement Co.	7/ 1/21	11/ 8/21	100	29,830.02		15,000.00*	Public Assessment and County Roads
Pt. Lobos Ave., Great Highway-48th Ave.	C. B. Eaton	9/22/21	6/22/22	100	179,748.73		120,000.00	County Roads and Property Owners
London St., Excelsior northerly 300 ft.	C. B. Eaton	1/24/21	12/23/21	100	2,341.50		2,341.50	General Fund
Geneva Ave. and Wallbridge St.	City Construction Co.	11/21/21	5/18/21	100	3,066.89		3,066.89	County Roads
Castro St. Widening, 17th St. to 19th St.	City Construction Co.	11/21/21		99	7,289.14			General Fund and Property Owners
San Jose Ave., Ottawa St. to Sickles Ave.	Raisch Improvement Co.	3/ 3/21		90	56,351.16		13,514.75	Public Assessment and County Roads
Balboa St., 23rd Ave. to 24th Ave.	Frank J. McHugh	8/ 4/22		80	10,800.20		1,125.00	Public Assessment and County Roads
Liberty St. and Sanchez St.	Schultz Construction Co.	4/ 5/22		70	60,091.36		2,200.00	Public Assessment and General Fund
Leavenworth St. Extension, McAllister St. to Fulton St.	The Fay Improvement Co.	4/18/22	6/ 8/22	100	3,913.55		3,913.55	General Fund
Great Highway, Westerly side, Cabrillo St. to Fulton St.	Pacific States Construction Co.	5/ 9/22			12,810.03			County Roads
Market St. Extension, Mono St. to 24th St.	Raisch Improvement Co.	3/24/22			(71,873.50)			Public Assessment and County Roads
Sewers								
Canal St., from Mission St. easterly	Burnham Plumbing Co.	6/24/20	8/18/20	100	5,115.63	5,115.63		General Fund
Canal St. Extension	Jas. T. Tobin	8/14/20	9/17/20	100	3,925.00	3,925.00		General Fund
Beach St., Polk St. to Columbus Ave.	W. J. Tobin	11/27/20	4/ 5/21	100	9,747.28	9,747.28		South Beach Land Fund
Stanyan St., Grattan St. to Frederick St.	T. D. Harney	2/ 4/21	8/ 3/21	100	10,941.60	10,488.80	10,941.60	General Fund
Woolsey St., Dartmouth St. to University St.	Cowden-Broderick Co.	8/ 8/21	11/12/21	100	5,503.50		5,503.50	General Fund
Third St., Sewer Outlet Extension	Healy-Tibbitts Construction Co.	8/ 8/22		95	(5,882.80)		5,500.00	General Fund
Great Highway, Noriega St. southerly	C. B. Cowden	6/24/22			10,095.95			General Fund
Lake St., Overflow Relief Gate	Schultz Construction Co.	6/ 3/22			212.50			General Fund

Contract amounts in parentheses ( ) are based on estimated quantities.
*Balance paid by private property owners.

No. W

121 Cen
122 Fur
wor
123 Fur
bod
124 Pai
125A Str
125B Str
125C Str
125D Str
126 Wo
127A Ste
127B T
127 C Tra
129 Ele
130 Cor
131 Ins
Con

Arn
R

Occ

Rel
Gre
Aqu
Aqu
Esp
Fir
Str

Contract

etchy
rated
mong
ig up
rials,
annel

t has
poses:
educt
casin
unit
ction
gton,
con-
pring
n the
and
owed,
from
will
reas-
casin

n the
occa-
peed.
Creek
ower

ulgas
ween

CURRENT CONTRACT DATA, 1920-1921 and 1921-1922 (Continued)

No.	WORK COVERED	CONTRACTOR	Date of Award	Date Completed	Per cent Completed to June 30, 1922	Amount of Completed Contract	Amount of City Funds Expended on Contract to June 30, 1921	Amount of City Funds Expended on Contract to June 30, 1922	FUNDS
		Municipal Railways							
121	Center Entrance Car	A. Meister & Sons Company	10/24/19	2/10/21	100	$ 16,419.15	$16,419.15	Completed in previous year	Municipal Ry Fund and Depreciation Fund
122	Furnishing and delivering track special work	U. S. Steel Products Co.	12/12/19	8/10/20	100	2,239.00	2,239.00	Completed in previous year	Municipal Ry. Depreciation
123	Furnishing and mounting automobile bus bodies	A. Meister & Sons Company	4/26/20	12/29/20	100	6,599.52	6,599.52	Completed in previous year	Municipal Ry. Depreciation
124	Painting Geary St. Car House	J. H. Mohr	12/23/21	3/ 8/22	100	1,353.00	.....	$ 1,353.00	Mun. Ry. Operating
125A	Street Cars—Bodies	American Car Co.	4/ 3/22		10	(103,740.00)	.....	.....	Mun. Ry. Depreciation
125B	Street Cars—Trucks	American Car Co.	4/ 3/22		15	(26,957.00)	.....	.....	Mun. Ry. Depreciation
125C	Street Cars—Motor Equipment	Westinghouse Elec. & Mfg. Co.	4/ 3/22		50	(49,503.66)	.....	.....	Mun. Ry. Depreciation
125D	Street Cars—Air Brake Equipment	Westinghouse Trac. Brake Co.	4/ 3/22		98	(11,148.60)	.....	.....	Mun. Ry. Depreciation
126	Wood Ties	J. R. Hanify Co.	12/23/21	3/15/22	100	21,322.96	.....	21,322.96	Mun. Ry. Depreciation
127A 127B	Steel Rails, Joints and Track Materials	U. S. Steel Products Co.	1/ 6/22		98	66,051.24	.....	64,055.00	Mun. Ry. Depreciation
127C	Track Materials—Tie Rods	Payne's Bolt Works	1/ 6/22	3/29/22	100	1,140.00	.....	1,140.00	Mun. Ry. Depreciation
129	Electric Cables and Splicing Material	Standard Underground Cable Co.	1/20/22	5/ 5/22	100	(28,785.46)	.....	28,785.46	Mun. Ry. Depreciation
130	Construction of Taraval St. Line Extension	Eaton & Smith	5/ 1/22		50	61,681.05	.....	9,000.00	Mun. Ry. Depreciation
131	Installing Concrete Poles and Electrical Conductors—Taraval St. Line Extension	Continental Construction Co.	4/21/22		75	8,630.02	.....	3,375.00	Mun. Ry. Depreciation
		Miscellaneous							
	Army St., Evans Ave. to Iowa St.—Retaining Wall	Healy-Tibbitts Construction Co.	12/19/19	8/ 2/20	100	40,257.00	40,257.00	Completed in previous year	General Fund
	Ocean Beach—Convenience Station	J. Spargo	3/12/20	1/12/21	100	32,966.13	32,966.13	Completed in previous year	General Fund
	Relief Home—150,000 gal. tank	Schultz Construction Co.	11/19/21	4/12/21	100	12,896.85	12,896.85	Completed in previous year	General Fund
	Great Highway—Board Walk	J. D. Hannah	5/19/20	1/20/21	100	13,494.00	13,255.00	.....	General Fund
	Aquatic Park—Grading	S. F. Motor Drayage Co.	3/ 4/21	6/ 8/22	100	25,141.07	8,440.12	25,141.07	South Beach Lands
	Aquatic Park—Trestle	Healy Tibbitts Construction Co.	9/17/21	1/18/22	100	17,770.73	.....	17,770.73	South Beach Lands
	Esplanade Section "C"	Clinton Construction Co.	8/19/21		99	142,851.28	.....	101,088.00	General Fund
	Fire Cistern	Schultz Construction Co.	11/ 4/21	5/17/22	100	6,885.00	.....	6,885.00	General Fund
	Street Signs	Schultz Construction Co.	11/16/21	4/ 6/22	100	6,937.70	.....	6,937.70	General Fund

Contract amounts in parentheses ( ) are based on estimated quantities.

HETCH HETCHY WATER SUPPLY.

Progress on the construction work of the Hetch Hetchy Water Supply and Power Project was very much accelerated during the fiscal years of 1920-1921 and 1921-1922. Among the factors operating to permit or facilitate this speeding up were a more abundant labor supply, lower prices of materials, and the favorable outcome of litigation by which the tunnel work had been hampered.

The work of this period on the City's great project has been directed toward the accomplishment of two purposes: First, the completion of the Hetch Hetchy dam, the aqueduct between Hetch Hetchy and Moccasin Creek, and the Moccasin Creek Power Plant, which, taken together, form the first unit of power development; second, the construction of the section of the Hetch Hetchy aqueduct extending from Irvington, Alameda County, to Crystal Springs reservoir, which in conjunction with certain work to be performed by the Spring Valley Water Company, will make available for use on the Peninsula the full capacity of the company's Alameda and Calaveras sources. Under the program now being followed, the City will be in a position to realize a large income from power sales about the year 1924, and in the same year will have ample water supply available to provide for its increasing needs until the Hetch Hetchy aqueduct from Moccasin Creek to Irvington is constructed.

Work on the Hetch Hetchy and Priest dams and on the aqueduct tunnels from Early Intake to the site of the Moccasin Creek penstocks, is going forward with all possible speed. The power units for an 80,000 KVA plant at Moccasin Creek have been contracted for, and work has begun at the power house site.

Construction is about to be commenced on the Pulgas tunnel, which forms the westerly end of the aqueduct between

Irvington and Crystal Springs, and the pipe line from Irvington to this tunnel is being designed.

The completion of the aqueduct between the Moccasin Creek plant and Irvington will require additional financing and several years' work after the financing is accomplished.

Organization

The whole work is under the general direction of M. M. O'Shaughnessy, City Engineer. N. A. Eckart, Chief Assistant Engineer, is in charge of the project, having supervision, under the general direction of the City Engineer, over all the Hetch Hetchy work.

City Headquarters Office:

The City Office staff designs and prepares plans and specifications for new work to be undertaken, prepares detail plans for work already in progress in the field, selects and purchases equipment for work being done by day labor or under "cost-plus-fee" contracts, and handles all bills and payrolls. Important items of this work done during these years are: design of details of Hetch Hetchy Dam and outlet system, Early Intake diversion works, Moccasin Creek Power Plant and penstocks, preparation of plans and specifications for Priest Dam and for Pulgas Tunnel, preliminary studies of Bay Crossing Division pipe line, and preparation of plans and specifications for a railroad relocation and plate girder bridge at Sixbit Gulch on the Hetch Hetchy Railroad.

Relief Map: For the information of the public, a large relief map of the entire Hetch Hetchy Water Supply project has been made and is on display in the rotunda of the City Hall. A relief map of the reservoirs and headworks on a larger scale, and models of Hetch Hetchy Dam, Lake Eleanor Dam and the Moccasin Creek Power Plant are parts of this display.

Field Headquarters in the Sierra Nevada:

Due to the rate of progress being made on the Hetch Hetchy Dam and Aqueduct Tunnels, it was advisable to put in effect the two division organizations originally contemplated for the work east of the San Joaquin Valley. On February 1st, 1921, Mr. Eckart, who had been supervising all construction activities on the project with headquarters at Groveland, was promoted to the position of Chief Assistant City Engineer, in charge of the Hetch Hetchy Project construction, with headquarters at San Francisco. Field headquarters for aqueduct construction, power plant construction, and railroad operation were continued at Groveland and placed in charge of L. T. McAfee, Construction Engineer. Headquarters for operations at Hetch Hetchy Dam, Hetch Hetchy Reservoir, Lake Eleanor and Mather Sawmill were established at Damsite in charge of C. R. Rankin, Construction Engineer.

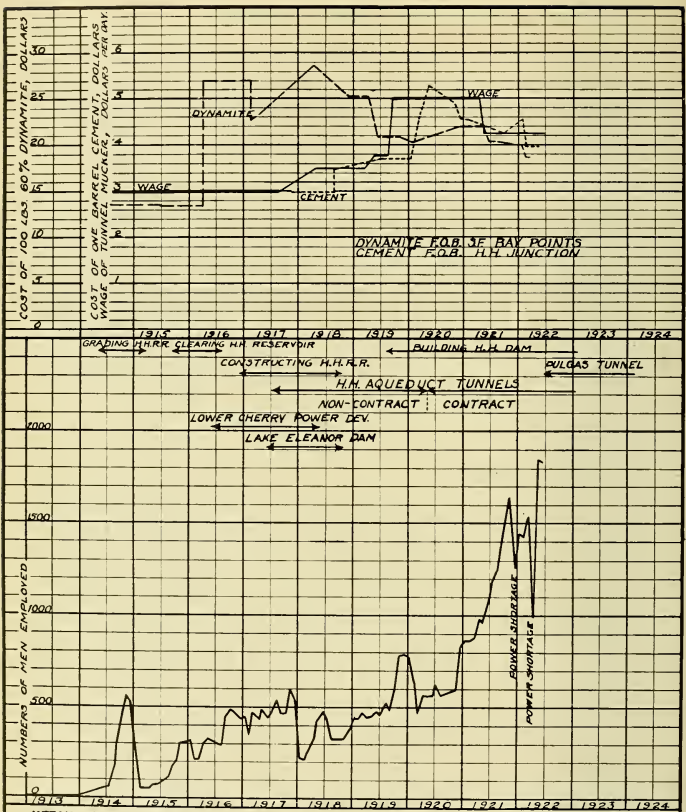
Boarding Houses:

A steward whose office is located at Groveland, has been placed in general charge of all boarding houses operated by the City, from Damsite to Hetch Hetchy Junction, in order that closer supervision might be maintained than was possible with the boarding houses operating independently of each other. The resulting economy, together with the decreased cost of foodstuffs, has practically eliminated the pecuniary loss on operation.

Refrigerating machines have been installed in connection with the boarding houses at all camps.

Employees:

The number of employees in the field during the past two years has varied from about 1000 to 1900, the average number being about 1400. The number and distribution for a typical day during June 1922, was as follows:



HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

UPPER: GRAPHIC RECORDS OF COSTS OF LABOR AND MATERIALS
LOWER: GRAPHIC RECORD OF NUMBER OF MEN EMPLOYED

NOTE: EMPLOYEES IN THE SAN FRANCISCO OFFICES ARE NOT INCLUDED IN THE COUNT

DEPARTMENT OF PUBLIC WORKS. APPROVED .. William M. Geoghegan Jr. ..... CITY ENGINEER
BY H. O. S. .. TRACED H. O. S. .. CHECKED .....
SCALE ..... DATE MARCH .8,. 1922.

A 165

Hetch Hetchy Dam	451
Priest Dam and Reservoir	271
Tunnels	721
Railroad	234
Temporary Power System	9
Sawmill	69
General	123
Total	1878

These figures include direct employees of the City and employees of the several contractors on the project.

A graphic record of the number of men employed on the project from January 1, 1913, to the present date is given on page 76.

Groveland Headquarters.

Office Building:

During the year 1921 the working force on this project was greatly increased, due primarily to the opening of the construction of the Priest Dam and Moccasin Creek Power House and tunnel. This necessitated an increase in the headquarters staff, requiring additional office space. A separate office building of temporary character was constructed adjacent to the main office building. In this are located the drafting room and assistant engineers' quarters, and office space which is rented to the tunnel contractors.

Fuel oil burners have been installed in the furnace of the main office building and all other furnaces, effecting a considerable economy and convenience in operation over the previous use of wood fuel.

Employees' Quarters:

The increased number of employees located at Groveland necessitated increasing the housing facilities. Several

cottages for families and a lodging house for single employees were erected, and an additional bunkhouse is being built to accomodate the shop men. An annex 24 ft. by 32 ft. was added to the previously constructed single employees' residence building, affording space for an additional living room and an extension to the dining room.

Due to the relatively short time now remaining before the completion of the Mountain Division, it is considered inadvisable to build any additional cottages for employees at Groveland.

Hospital:

The large increase in number of employees on the work has necessitated a slight increase in the personnel of the hospital, there now being engaged a physician, an interne, three nurses and two porters.

The City carries compensation insurance with the State Compensation Insurance Fund protecting all of its employees. The City, by maintaining its own hospital, saves the State Fund the expense of providing for the care of employees injured in the performance of their duties on the work, and in consideration of this saving the Fund allows the City a reduction of 15% from the regular premium rates.

The medical service also takes care of employees who become injured or ill from causes not incidental to their occupations. A hospital fee of one dollar per month is deducted from each man's pay for this service. Applicants for employment are examined by the physician before being accepted, to prevent the medical service being burdened with the care of men who may become incapacitated on account of causes existing prior to employment by the City.

The hospital service is available to others than employees at regularly established rates which are charged for the use of the hospital facilities. This is a great convenience to the

inhabitants of the region covered by the City's work, as there is no other hospital nearer than Sonora, 27 miles by road from Groveland.

Cases treated at the hospital during the past two fiscal years were as follows:

	1920-21		1921-22	
Non-hospital cases		648		1069
Hospital cases:				
City's direct employees	147		176	
Construction Company of North America employees	146		326	
Utah Construction Company employees	3		1	
Outside pay patients	57		148	
Total hospital cases		353		651
Total cases treated		1001		1711
Capital operations		5		72
Average time in hospital for hospital cases		6.45 days		9.5 days

The hospital has a capacity of 26 patients, including one isolation tent, and is more fully equipped than are most hospitals on similar projects. In the few cases which require the attention of specialists or long protracted hospital treatment, the patients are transferred to the San Francisco City and County Hospital.

The medical service is self-supporting, the sum of the revenues from payroll deductions and outside patients and the saving on compensation insurance being approximately equal to the total expense of maintaining the service.

The City requires contractors either to avail themselves of the City's medical service for their employees, at the rate per man per month established in the contracts, or to maintain

proper facilities at their own expense to care for their men. The Utah Construction Company, building the Hetch Hetchy Dam, has adopted the latter course, sending occasional cases to the City's hospital for treatment which the company's less elaborately equipped establishment at Damsite is not prepared to handle.

Groveland Water Supply:

The town of Groveland is now supplied with water by the City. The former supply was taken from the Golden Rock Ditch, which was constructed many years ago to bring water from the South Fork of the Tuolumne River to mines in the vicinity of Groveland and Big Oak Flat. Since the mines shut down the ditch has received little attention from its owners, the water flowing in it diminished in quantity and deteriorated in quality, and in 1920 it became necessary for the City to make other arrangements to supply water for its buildings, both for domestic supply and for fire protection, and for its locomotives.

A quantity of water of good quality much more than ample for such purposes was being pumped from the Second Garrotte shaft pumping station, 250 feet underground. A line of six inch dipped wood stave pipe 9300 feet in length was laid from the shaft to two 30,000 gallon tanks on a hillside just above the town, at such height as to give a pressure of 100 pounds per square inch in the distributing pipes. An additional 1600 feet of six inch wood stave pipe connects from the tanks to the distributing system.

The sump in the shaft pumping station is divided into two sections by a concrete wall, and the section from which water is pumped to Groveland receives only water intercepted at points above the bottom of the shaft. This is to avoid contamination of the supply by the water from the bottom. The pure water is pumped by a Gould trip-

plex pump, electrically driven, with a capacity of 250 gallons per minute.

Shortly after the new system was put in operation, a fire occurred which destroyed several stores and dwellings in Groveland. The Second Garrotte water was used to fight this fire, and was undoubtedly the salvation of the town. The citizens thereupon formed a water users' association and entered into an arrangement with the City under which surplus water over that necessary for the City's purposes is made available to them. The association is paying $2500 in monthly installments of $50, with interest at 6% on the unpaid balance, as its share of the cost of constructing the system, and also pays a pro rata of the expense of operation and maintenance, based on the ratio of the quantities of water used by the City and the town, respectively, from the system. A three-inch meter was installed at the point of connection to the City's main, and a new main was constructed to connect to the town distribution system, all at the expense of the association.

The total supply furnished to the storage tanks from the shaft is about 200,000 gallons daily, of which about 135,000 gallons is used by the City's establishment and 65,000 gallons by the townspeople.

Groveland Warehouse:

The central warehouse at Groveland has been found an important factor making for efficiency and economy. The warehouse force has been increased from 15 to 29 during the past year on account of the much larger amount of material which is handled, due to the additional activities. Stocks of tools, spare parts for equipment, and construction and boarding house supplies, for all work except that of the Utah Construction Company (Hetch Hetchy Dam), are kept on hand and shipped out to the work as

ordered. This eliminates delay in delivery, permits purchasing in large quantities at the lowest prices, and facilitates the cost accounting. A more complete stock of repair parts has been kept than in previous years, so as to avoid danger of retarding or shutting down any portion of the work on account of lack of machine parts.

All shipments are billed in to the warehouse and the unit prices, including freight charges, determined there. To maintain uniformity in accounting all heavy equipment is charged through the warehouse in this manner, although it may be actually delivered directly to the work. Since camps have been opened between Groveland and Hetch Hetchy Junction, it has been found advisable to detail one man from the warehouse for service at Hetch Hetchy Junction, to divert shipments destined to these camps, so that they need not actually pass through the warehouse at Groveland. This idea has worked out well, and has simplified and cheapened the delivery of material to the westerly camps, such as Priest Dam and Reservoir and Moccasin Creek.

Groveland Shops:

The shop equipment was augmented by the installation of a wheel lathe, a 36-inch by 18-foot geared lathe, a portable boring mill, and a 36-inch by 12-foot planer. The Groveland shops now handle practically all overhauling and repairing of locomotives, motor cars and other rolling stock of the Hetch Hetchy Railroad, and repairs to construction equipment which are beyond the capacity of the comparatively small blacksmith and machine shops at the various camps. Delays incidental to having such work done in outside shops are thus avoided and the amount of rolling stock and other equipment out of service awaiting repairs is reduced to a minimum. Very complicated boiler work and heavy forging, on the rare occasions when such work

is required, is done in the Southern Pacific Shops at Sacramento.

A 12-stall roundhouse has been built close to the locomotive turntable, to house railroad motor cars. This building includes also a repair shop for the motor equipment. A 12-inch by 8-foot lathe was moved here from the main shop, and a new drill press, emery wheel and other machine tools have been installed.

The shop force has been increased to 40 to handle the repairs of tunnel machinery.

Railroad Yard:

On account of unsatisfactory operation of the locomotive turntable, due to limited capacity, a wye for turning engines was constructed. The Groveland Yard was also greatly enlarged to take care of the increase of freight traffic, due mainly to the hauling of cement to Hetch Hetchy Dam.

Groveland Sewer System:

Acting upon recommendation of the State Board of Health, the City inaugurated the construction of a sewer system in Groveland. It was decided that the City should first construct its portion of the sewer, and then persuade the townspeople to construct the portion through their property. Acting upon this idea, in the Spring of 1922, the City constructed 1150 feet of 8-inch ironstone pipe sewer, and the other inhabitants of the town are preparing to continue the work. It is to be hoped that the completion of the sewer and the disposal of sewage through it will improve the sanitary conditions in the town. These conditions have been very poor and as the town has grown materially, would be far worse each succeeding year without some such provision for a sewer system. At the outfall of the City sewer,

the town will construct a septic tank, the effluent of which will be used to irrigate a farm about one-half mile north of the town.

Road and Bridge Work.

The Big Oak Flat Road, or Tioga State Highway, which traverses the same country as the Hetch Hetchy Aqueduct, and in a general way parallels the Hetch Hetchy Railroad, is very largely used by the City in furtherance of the construction work. This road, since its being taken over from the County by the State, some six or eight years ago, has been very poorly maintained. During the winters it is all but impassable from Priest Hotel easterly through Groveland, Second Garrotte, etc. The City, in an effort to co-operate with the State and keep the road passable for traffic in the winter time, contributed several carloads of crushed rock from the Big Creek shaft, to be used in surfacing this road. The State hauled and distributed this material by truck and macadamized a small portion of the road. The County Supervisor, resident in Groveland, continued the work through the main portion of Groveland, so that it is hoped that the road will be passable, at least for light automobiles, during the coming winter months.

Besides the ordinary work necessary to keep the roads to the various camps in condition for the hauling of construction equipment and supplies, road work was done during the period as follows:

The existing road from South Fork to Mather has been maintained in accordance with the provisions of the Hetch Hetchy Grant.

As a precaution against accidents, a road change was made in the vicinity of Mile 47 on the railroad to eliminate

a double road crossing between South Fork and Jones Station.

Branch roads were constructed to give access to Adits 5-6 and 8-9.

The road from Jones Station and Intake Siding down into the river canyon at Early Intake was improved, graded and ditched.

Early Intake Bridge: This bridge, crossing the Tuolumne River, connects the last mentioned road to the roads leading to the Lower Cherry Aqueduct, the construction power plant, and the part of the Early Intake Camp occupied by the married men's cottages. It was built in 1916, using local hewn timbers. Some of these timbers were found to be badly decayed, necessitating the reconstruction of the bridge, for which work Oregon pine timbers were used, which are stronger and deteriorate more slowly than the local pine. At the same time the bridge was raised 2½ feet, for safety under extreme flood conditions.

Hetch Hetchy Dam.

The Hetch Hetchy Dam is being constructed to an initial crest elevation of 3726.5 feet, or 226.5 feet above the original stream bed. The design allows for ultimately raising the crest to elevation 3812, or 312 feet above the streambed. The foundations, and a part of the dam which includes six outlet conduits, are being built to the horizontal dimensions required by the plans for the ultimate structure.

The Utah Construction Company, under Contract No. 61, has been continuously engaged in the construction of the dam.

Water Control:

Stream Diversion: The low dams and the tunnel which were built to pass the river around the damsite during the construction of the main dam are described in previous reports.

The upstream diversion dam is a rock-filled timber crib resting on the sand and gravel of the riverbed, with plank sheathing on the upstream face and with sheet piling extending down through the sand and gravel to an impervious stratum, but not to bedrock. It was to be expected that there would be some leakage past this structure, and also some seepage from the formation beneath the impervious material into the foundation pit, which would then have to be kept dry by pumping. In fact, it would not have been at all surprising if the latter seepage had been too great to handle by means of pumps, and in anticipation of such a contingency the contractor provided himself in advance with part of the equipment necessary to sink caissons to bedrock. Fortunately the underflow proved quite small.

Previous to the flood season of 1922, the Hetch Hetchy dam had been built up to a height higher than the upstream diversion dam, making further maintenance of the diversion dams unnecessary. A 12 by 12 foot tunnel was left at streambed level in the main dam, and a part of the river flow passed through the dam. The peak of the 1922 flood was on June 6th, when the flow of the Tuolumne River was 9,500 second feet. During June, the average river flow was about 7,000 second feet, and the floor of the valley above the dam was flooded. During the time when the outlet valves are being placed in the diversion tunnel, all the water will be turned to flow through the dam. The 12 by 12 foot tunnel will later be filled with concrete.

Pumping: Except in the high water season, the water entering the foundation pit was handled by one eight-inch and three six-inch centrifugal pumps operating about one-third of the time. In 1921, when the spring flood was at its peak, the flow through the diversion tunnel was considerably over 8,000 cubic feet per second, and the whole valley floor was flooded, the water being 33 feet deep at the upstream side of the diversion dam and 1.6 feet above the bottom of the foundation excavation. The leakage then required the continuous operation of one fourteen-inch, two eight-inch and three six-inch centrifugal pumps. In addition, one twelve-inch pump was kept in readiness, but it was not necessary to operate it.

Progress:

The accompanying table shows the amount of different classes of work done under Contract No. 61 to June 30, 1922, and the value, at the contract prices, of the work performed.

HETCH HETCHY DAM (CONTRACT 61)

Itemized Record of Construction Progress

Showing work performed before and during the fiscal years of 1920-1921, 1921-1922, and estimated quantities still remaining to be done.

Item No.		To June 30, 1920	During Year 1920-1921	During Year 1921-1922	To June 30, 1922	Amount Unfinished June 30, 1922
1	Excavation of earth and loose rock in open cut, below elevation 3500, cu. yds.	0	51,106	0	51,106	Completed
2	Excavation of solid rock in dam foundation, below elevation 3500, cu. yds.	0	16,514	3,953	20,467	Completed
3	Excavation of earth and loose rock in open cut above elevation 3500, cu. yds.	5,000	9,527	10	14,537	13,963
4	Excavation of solid rock in dam foundation above elevation 3500, cu. yds.	45,000	34,808	106	79,914	Practically completed
5	Excavation in tunnel and shaft, cu. yds.	10,511	86	1,320	11,917	Practically completed
6	Cyclopean masonry below elevation 3500, cu. yds.	0	0	54,201	54,201	Completed
7	Mass concrete below elevation 3500, cu. yds.	0	0	23,533	23,533	Completed
8	Cyclopean masonry above elevation 3500, cu. yds.	0	0	127,033	127,033	124,767
9	Mass concrete above elevation 3500, cu. yds.	0	0	11,247	11,247	32,953
10	Mass concrete in tunnel and shaft, cu. yds.	382	0	0	382	2,118
11	Reinforced concrete, Class "A," cu. yds.	0	0	0	0	200
12	Reinforced concrete, Class "B," cu. yds.	0	0	0	0	300
13	Precast dense concrete blocks, cu. yds.	0	0	411.10	411.10	138.90
14	Precast porous concrete blocks, cu. yds.	0	0	1,467.44	1,467.44	132.56

HETCH HETCHY DAM (CONTRACT 61)—Continued

Itemized Record of Construction Progress

Showing work performed before and during the fiscal years of 1920-1921, 1921-1922, and estimated quantities still remaining to be done.

Item No.		To June 30, 1920	During Year 1920-1921	During Year 1921-1922	To June 30, 1922	Amount Unfinished June 30, 1922
15	Mortar, 1″ thick, placed by cement gun, sq. ft.	0	0	13,258	13,258	Completed
16	Mortar, ¾″ thick, placed by cement gun, sq. ft.	0	0	17,832	17,832	64,168
17	Grout placed under pressure, cu. yds.	0	0	1.11	1.11	198.89
18	Extra cement, bbls.	0	0	0	0	10,000
19	Screen Rack No. 1	0	0	0	0	1
20	" " " 2	0	0	0	0	1
21	" " " 3	0	0	40%	40%	60%
22	Grout holes in rock, lin. ft.	0	0	0	0	1,000
23	" " " masonry, lin. ft.	0	0	0	0	1,000
24	Drainage holes through masonry, lin. ft.	0	0	145	145	735
25	Steel reinforcing bars, lbs.	0	0	0	0	48,700
26	Galvanized steel or iron work, lbs.	0	0	0	0	23,600
27	Bronze, lbs.	0	0	928.22	928.22	1,871.78
28	Galvanized pipe and fittings, lbs.	0	0	2,340.12	2,340.12	10,660
29	Galvanized chains, lbs.	0	0	0	0	200
30	Cast iron gratings and frames, lbs.	0	0	0	0	800
31	Copper water stops, lbs.	0	0	6,149	6,149	3,851
32	Placing metal work furnished by City, lbs.	2,450	0	396,130	398,580	1,691,420
33	Doors faced with galvanized iron, sq. ft.	0	0	0	0	530
34	Painting concrete surfaces in waterways, sq. ft.	0	0	0	0	17,000
35B	Acquiring and conveying to the City the legal right to construct and operate siphon spillway	0	0	Completed	Completed	Completed
	Contract price of work performed	$255,324	$713,388	$2,677,448	$3,646,160	$2,075,050

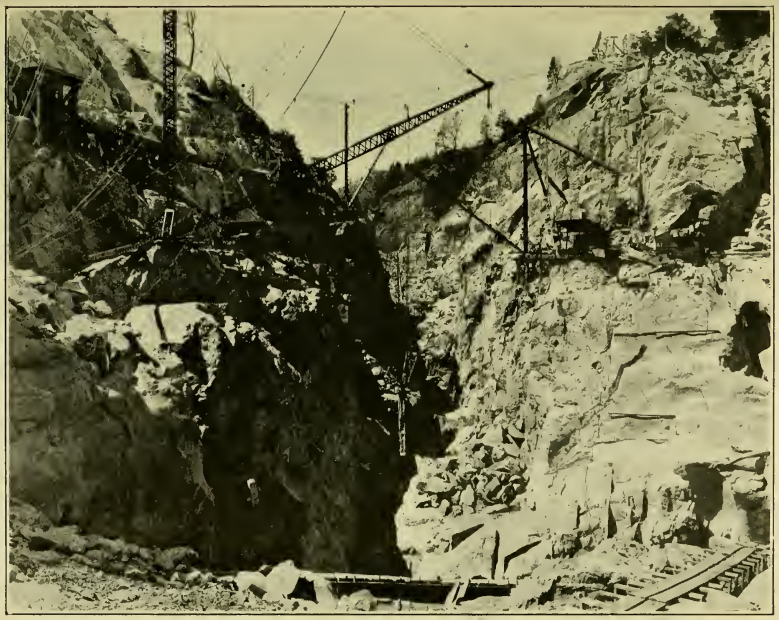
Excavation. (Items 1, 2, 3, and 4): The excavation of the material overlying the dam foundation and in the cutoff trench is classified according to whether it lies above or below the plane whose elevation is 3500 feet. This plane represents approximately the streambed at the upstream side of the dam, previous to the beginning of excavation.

Excavation below elevation 3500 was completed in August, 1921. Excavation above elevation 3500 was practically completed before September 1, 1921. A few men have been engaged since that time in barring down loose fragments and cleaning off the bedrock ahead of the concrete pouring.

Excavation on the sidewalls and in the cutoff trench above the stream bed level was carried on by drilling with jackhammers and shooting and barring down the material to the river bed, where it was loaded into trains of narrow-gauge, 4-yard side-dump cars by a Marion No. 36 steam shovel on crawler treads. The trains were hauled by 18-ton saddle-tank locomotives to a waste bank near the crusher plant and the excavated material was dumped there, where it can be readily re-excavated to be screened and crushed for concrete aggregate.

On reaching the river bed level the steam shovel was used in excavating the foundation pit for a depth of 65 feet, to elevation 3435. In the lower part of the steam shovel excavation, the trains operated on a very steep incline, with a maximum grade of 20%. The trains were worked on a counterbalance system, the empty train entering the pit helping the loaded train up the steep grade.

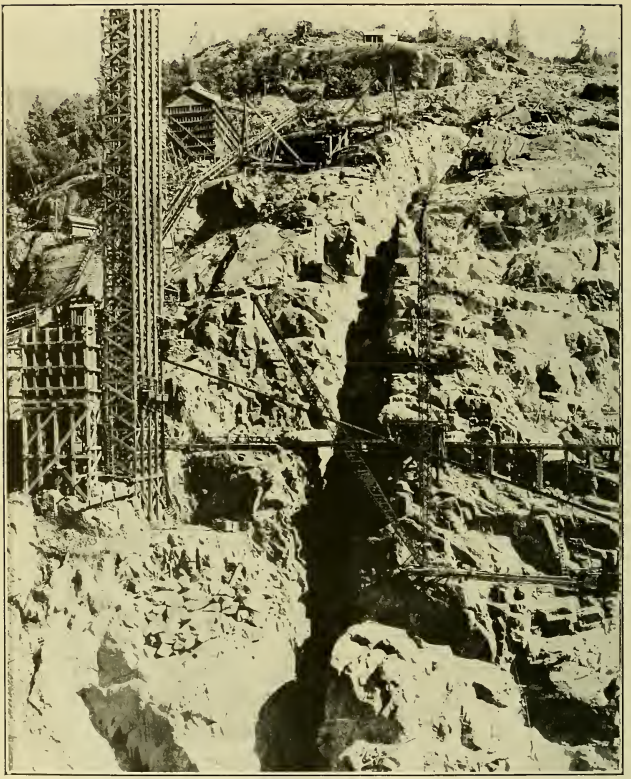
Below elevation 3435 the track grades became too steep for train haulage and the space between the solid rock walls too narrow to permit economical use of the steam shovel, so that derricks were resorted to, lifting the excavated material out in skips and emptying the skips into the trains,



HETCH HETCHY DAM—GENERAL VIEW OF DAMSITE LOOKING DOWNSTREAM.

(August 15, 1921.) Excavation for foundations practically completed. Chute in place for pouring concrete in lowest portion of foundation. Large pieces of rock piled on convenient ledges to be used as "plums" in cyclopean masonry.

The maximum depth of excavation is 118 feet below the original stream bed in solid granite. The river has been turned through a large tunnel penetrating the rock ridge at the left.



HETCH HETCHY DAM—VIEW OF SOUTH ABUTMENT

(August 18, 1921.) Showing cut-off trench and stepped form of excavation. Concrete hoist tower at the left and bulk cement storage bin above.

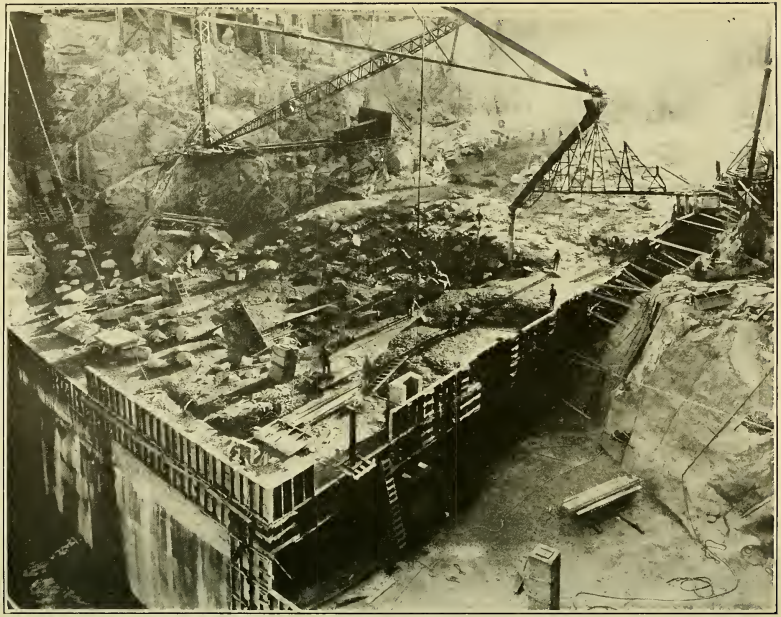
which from that time forward have been operated on trestles along the steep side walls of the damsite.

At elevation 3439 at the downstream toe, bedrock was encountered and a concrete retaining wall, 31 feet in height, was built, sealing off all seepage into the lowest portion of the foundation. At the upstream toe, on reaching an elevation of 3435 a cofferdam was sunk to bedrock, elevation 3399, and a concrete retaining wall was poured, cutting off practically all seepage into the pit proper.

In addition to removing all material overlying the bedrock, it was necessary to prepare the bedrock for receiving the concrete. This was done largely by sand-blast, which removed all scale or glaze from the rock, leaving a clean, raw surface ready for bonding the concrete.

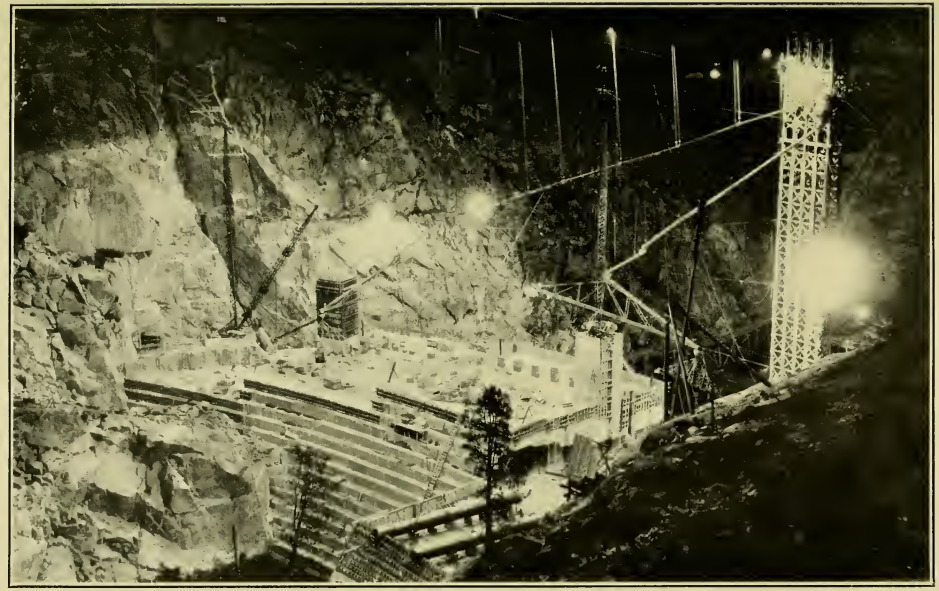
Shaft Excavation (Item 5): A 5 by 7 foot pilot shaft was sunk from elevation 3580, on the upstream face of the dam, to the diversion tunnel, within the space to be occupied by the large valve shaft, and later was enlarged to 26x20 feet. The excavated material was dropped down upon a heavy platform in the tunnel. From the platform, the material was removed in 4-yard side-dump cars, hauled by a hoisting engine stationed outside the tunnel. The excavation of the shaft was done during the low water season, and completed October 31, 1921. The excavation of a small shaft leading to the turbine chamber in the tunnel was completed in August, 1921. Work on the valve and turbine chambers is to be begun as soon as the present high water recedes.

Concrete below elevation 3500 (Items 6 and 7): Placing of mass concrete and cyclopean masonry was started in September, 1921, and has been carried on almost continuously since that date. The portion below the 3500-foot level was completed early in January 1922.



HETCH HETCHY DAM

(November 20, 1921.) Pouring concrete in base. Maximum width of dam at base is 298 feet. Contraction joint in right foreground of view, upstream face of dam at the left.



HETCH HETCHY DAM

(June 6, 1922.) Showing downstream face and top of concrete poured. The forms for the lowest set of outlet conduits are shown set in place (lower center). The square blocks setting on top of the dam are pre-cast concrete sections of drainage wells. This illustration also shows the illumination of the dam for work at night.

Concrete above elevation 3500 (Items 8 and 9). This work is a continuation of Items 6 and 7. By June 30, 1922, the top of the dam had been brought to elevation 3600, or 100 feet above streambed, and 218 feet above the foundation bedrock at the upstream face.

The following table shows the progress made by months:

September, 1921	15,447 cu. yds.
October, 1921	21,479 cu. yds.
November, 1921	27,593 cu. yds.
December, 1921	19,583 cu. yds.
January, 1922	24,823 cu. yds.
February, 1922	15,219 cu. yds.
March, 1922	10,980 cu. yds.
April, 1922	12,866 cu. yds.
May, 1922	41,178 cu. yds.
June, 1922	26,845 cu. yds.
Total to June 30, 1922	216,013 cu. yds.

The amount of concrete placed month by month is shown diagramatically on the following chart.

Concrete was poured only on the day shifts until December, 1921, when a night shift was started. From that time on, both night and day shifts have been working.

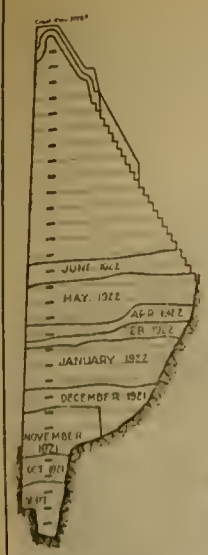
Wooden forms consisting of 5-foot by 8-foot panels are used, and are held in place by 3/16″ tension wires anchored in the concrete with wire hooks. After the forms are removed, a coating of gunite is applied to the upstream face.

During the cold weather period from December to March, a heating plant consisting of a large steam boiler and circulating pipes was installed to prevent the concrete from freezing.

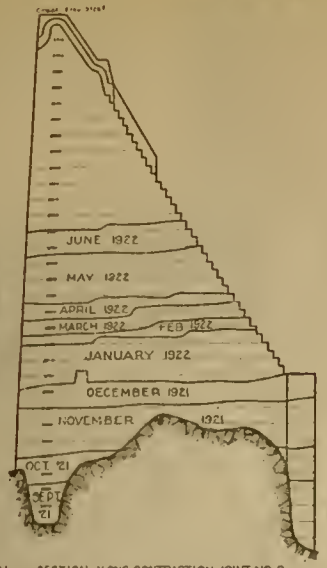
Large stone, or plum rock, has been placed in cyclopean concrete to an amount equal to 8% of the mass.

ı of the
when the
ompleted
point of

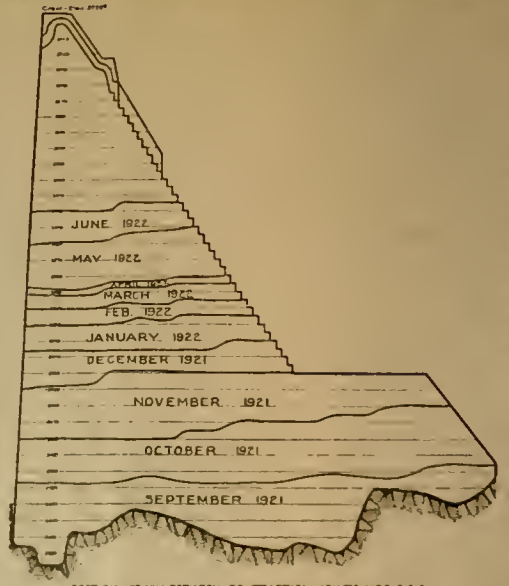
HETCH HETCHY DAM
PROGRESS CHART OF CONCRETE PLACING



SECTION ALONG CONTRACTION JOINT NO 1
FOR PROGRESS BETWEEN
END OF DAM & CONTRACTION JOINT NO 1

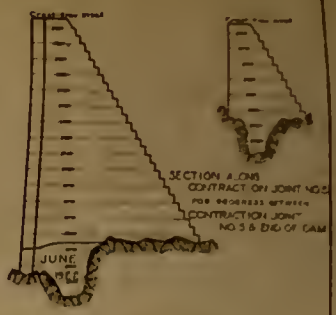


SECTION ALONG CONTRACTION JOINT NO. 2
FOR PROGRESS BETWEEN
CONTRACTION JOINTS NOS. 1 & 2

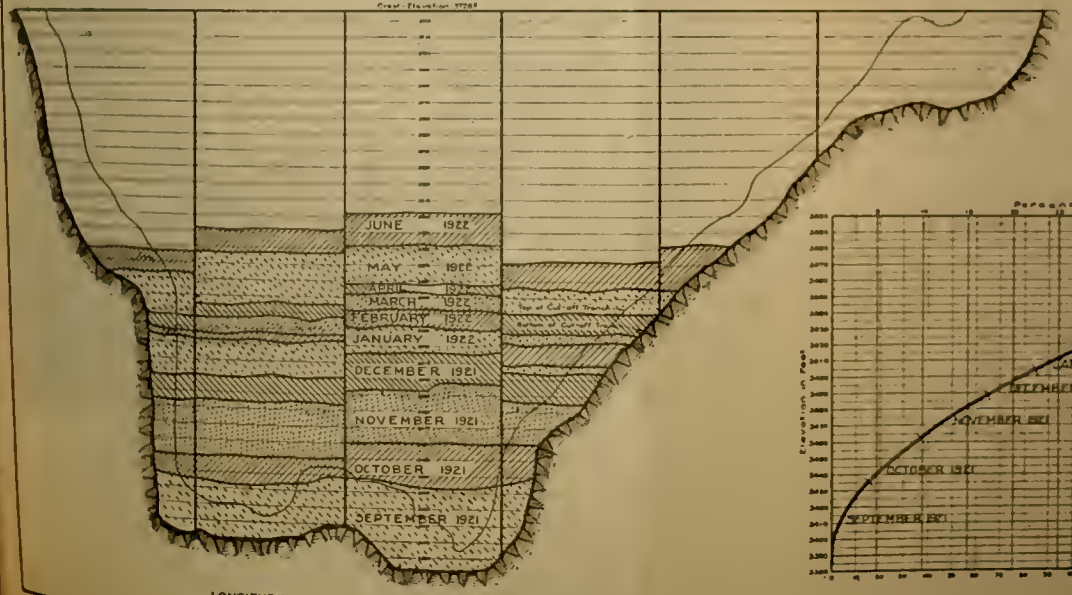


SECTION MIDWAY BETWEEN CONTRACTION JOINTS NOS 2 & 3
FOR PROGRESS BETWEEN
CONTRACTION JOINTS NOS 2 & 3

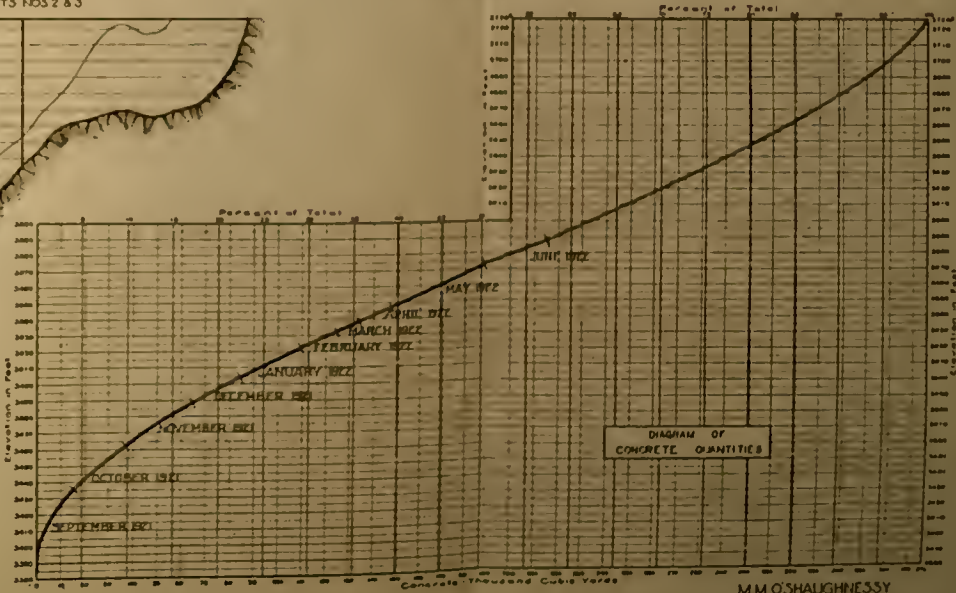
SECTION ALONG CONTRACTION JOINT NO 3
FOR PROGRESS BETWEEN
CONTRACTION JOINTS NOS 3 & 4



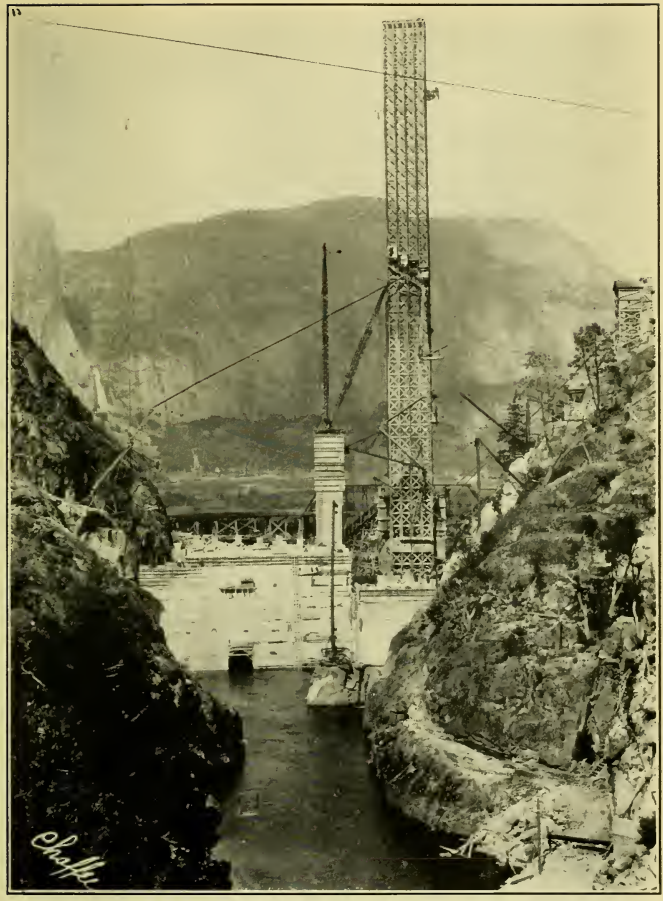
SECTION ALONG CONTRACTION JOINT NO 4
FOR PROGRESS BETWEEN
CONTRACTION JOINTS NOS 4 & 5



LONGITUDINAL SECTION ALONG CUT-OFF TRENCH



M.M. O'SHAUGHNESSY
CITY ENGINEER



HETCH HETCHY DAM

(April 24, 1922.) General view looking up-stream showing a portion of the reservoir site in the background and timber tower for elevating concrete.

The flood control tunnel through the dam will be plugged with concrete when the dam is completed.

The top of the timber tower is 380 feet above the water level. The completed initial dam will be 226 feet above this level, or 344 feet above the deepest point of the foundation.

The general plan of pouring concrete is to keep the back or downstream face of the dam from five to fifteen feet higher than the upstream face, creating five-foot steps where the pour is discontinued.

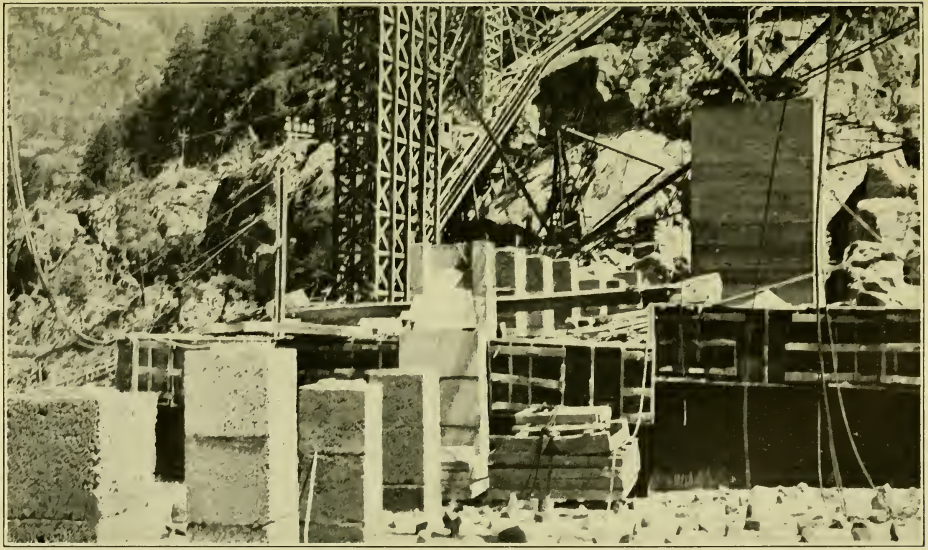
Shaft Lining (Item 10): A part of the lining of the small shaft, which is to give access to a turbine generator placed in the chamber off the present diversion tunnel, was done during the winter of 1921-22. The work will be continued when the water lowers in the coming fall.

Precast Concrete Blocks (Items 13 and 14): Dense blocks, for lining the inspection wells, and porous blocks, for lining drainage wells in the dam, are being manufactured as fast as needed to keep well ahead of the concrete pouring.

Mortar Placed by Cement Gun (Item 15): The upstream face of the dam is being coated with cement mortar, placed with a cement gun, as the structure progresses. The mortar coating is one inch thick below and ¾ inch thick above elevation 3500.

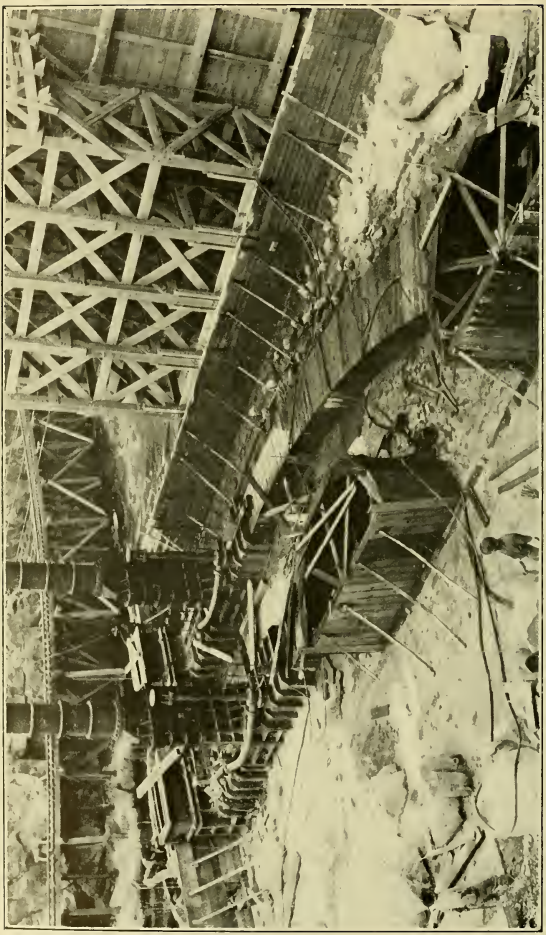
Screen Rack (Item 21): Reinforced concrete screen racks will cover the openings from the reservoir into the outlet system and will prevent logs or other debris from entering the supply wells and damaging or becoming lodged in the valves. Screen Rack No. 3 is now 40% completed.

Copper Water Stops (Item 31): The dam is divided into six sections by five contraction joints. The concrete is prevented from bonding across these joints by a coat of asphalt. Passage of water along the joints is prevented by water stops made of 1/16″ sheet copper, extending into the concrete, which is cast around the water stop on each side of the joint. The copper sheet is bent to a form which



HETCH HETCHY DAM—DRAINAGE AND INSPECTION WELLS

Drainage wells formed of pre-cast porous concrete blocks 3 feet 3 inches square, with 15-inch square hole in center. Inspection well formed of pre-cast dense concrete blocks shown in center of view, bisected by a contraction joint.



HETCH HETCHY DAM—47 INCH BY 90 INCH SLIDE GATES
With forms for conduits and supply wells through which water will pass to the 5-foot balanced needle valves. (June 6, 1922.)

will permit the sheet to accommodate itself to any movement of the adjacent concrete.

Valves for Outlet System (Item 32): Delivery has been made to Damsite of:

6—5-foot balanced needle valves.
6—3-foot balanced needle valves.
6—47″x90″ slide gates.
6—33″x42″ slide gates.

The slide gates are hydraulically operated. The needle valves are hydraulically balanced and manually controlled. The twelve needle valves are to control the discharge from the reservoir. The six 5-foot balanced valves will be installed in the dam section proper, and will take water from two supply wells. Of the 3-foot balanced valves three will be placed in the dam section and three in the tunnel that is now used for stream diversion. The slide gates will be located ahead of the balanced valves to control the water to the supply wells and will be used to shut off the water in the event of repairs being necessary on the balanced valves.

The valves and gates represent nearly one thousand tons of metal work. They are stored near the site of the work, ready to be installed as the concrete work progresses. Two of the large slide gates and two of the 5-foot balanced needle valves have been installed in the dam, and concrete has been poured around the lowest pair of discharge conduits through the dam. The placing of these balanced valves and gates constitutes nearly all of the work done under Item 32, "placing metal work furnished by the City."

Construction Plant and Heavy Equipment:

Derricks: To handle the material from the deep excavation, and later to place plum rock in the cyclopean masonry, one steel derrick with 100 foot boom, one with

110 foot boom, one wooden guy derrick with 70 foot boom and one with 60 foot boom were erected. These so overlap as to cover all points in the lower portion of the dam. In connection with the derricks a high railroad line was built on the south abutment at elevation 3540, connecting with the valley railroad system by crossing on the diversion dam, and a railroad track was also placed at the same elevation on the north abutment. Dumping platforms were arranged on these railroads, enabling the derricks to unload 3-yard skips directly into the dump cars. When concrete work is under way, the derricks handle loaded skips of plum rock from the flat cars to the cyclopean masonry without interfering with the pouring operation.

Cableway: A 15-ton Lidgerwood cableway with a span of 903 feet of 2¼-inch cable, supported on towers 528 feet above the bottom of the foundation pit, and having a speed of 900 feet per minute, has been erected. The cableway is so placed as to permit handling the five-foot balanced valves on the face of the dam and the three-foot valves down the shaft to the diversion tunnel.

Machinery, industrial locomotives and other heavy equipment, lumber and timbers, etc., are handled by this cableway from cars standing on the track of the Hetch Hetchy Railroad, to the narrow-gauge cars of the contractor's industrial railroad on the valley floor level. The drop from one track to the other is over 300 feet.

Valley Railroad: The Contractor's narrow-gauge railroad now extends four miles from the dam to Rancheria sandpit at the head of the main Hetch Hetchy Valley. The upper portion of the railroad is located on the north side of the valley, being excavated in places along the granite cliffs to keep above the high water of the Tuolumne River. This extension required some fairly heavy work and a trestle across Rancheria Creek. Sidings and spur tracks to the

crusher plant, sand plant and the concrete block plant have been built. Repair shops have been established, and water tanks, to supply water to the locomotives, have been installed. Additional rolling stock was brought in during 1921, making a total of ten 18-ton locomotives, ninety-two 4-yard dump cars, twelve flat cars, and nine tender cars.

This railroad was built to haul the excavated material from the dam foundation to the dump in the valley, and to bring sand and rock from natural deposits and from the dump and quarries to the crusher plant for washing, screening and crushing, and to haul the crushed rock and clean sand to the concrete mixing plant at the dam.

Rock Crushing Plant: A rock crushing plant to produce aggregate for concrete has been erected on the valley floor. The material, ranging from sand up to boulders and rock fragments about one cubic foot in volume, is brought to the plant in trains of 4-yard dump cars. It is passed over a grizzly with bars spaced six inches apart. The rock which does not fall through the grizzly is passed through the primary crushers consisting of a Kennedy-Van Saun gyratory crusher, with a capacity of 200 cubic yards per hour, and a Power Mining Machinery Co. 24″x36″ jaw crusher, with a capacity of 100 cubic yards per hour. The former is driven by a 200 H. P. motor, the latter by a 150 H. P. motor. These crushers are arranged with independent feeds and belt conveyors.

From these crushers 30″ belt conveyors carry the crusher-run rock and the material that passes through the grizzly to a ¼″ mesh revolving screen. The fine material or sand passing through this screen goes to a log washer, and the coarser material is run through a 2½″ revolving screen, the rejects continuing to a No. 6 McCully gyratory crusher and a No. 49 gearless, belt-driven Kennedy-Van Saun crusher, set for producing two-inch rock. The re-

crushed rock is carried to a revolving ¼″ manganese steel screen into which jets of water under high pressure are sprayed, separating all crusher dust and diverting it to the log washer.

After the final crushing of the rock and separation of crusher dust, these materials are elevated on belt conveyors to a trestle 38 feet high, and discharged into storage piles, one for rock and one for sand, under which are two trap tunnels with mining dump doors, spaced 14 feet on centers. This storage has a capacity of 8,000 cubic yards of sand and crushed rock. From the storage piles 4-yard side dump cars are loaded with aggregates by gravity, the spacing of the trap doors permitting all the cars of a train to be loaded without moving the train.

Sand Plant: A sand plant has been installed adjacent to the rock crushing plant. This plant has an independent spur track, so that sand trains, consisting of twelve 4-yard side-dump cars, can make delivery into the receiving hopper without delay. From the receiving hopper, the sand is elevated 65 feet by a bucket conveyor to the sand screen, consisting of an inner screen 42″ in diameter and 24 feet long, of ⅜″ plate with ⅞″ punched holes, and an outer wire woven screen 72″ in diameter and 24 feet long, of ¼″ mesh. The material refused by this screen is dropped down a chute to the belt conveyor leading from the primary crusher and is run through the secondary crushers. A 1″ wire mesh screen is inserted in this discharge chute and the clean gravel secured for use in the reinforced concrete for screen racks, etc. The sand, after passing the inner screen, drops to a 24″ conveyor belt, and is carried to a stock pile one hundred feet long by thirty feet high. This stock pile has 3,000 cubic yards of live storage and the plant has a capacity of 100 cubic yards per hour. Under the sand pile, a narrow-gauge tunnel is framed with mining gates so placed as

to permit the loading of 4-yard dump cars without moving the train.

Concreting Plant: A concrete mixing plant with a capacity of 100 cubic yards per hour has been installed near the upstream face of the dam, on the south abutment, at elevation 3540, 158 feet above the lowest point in the foundation pit and 187 feet below the crest of the dam.

This plant consists of two 2-yard motor-driven Ransome mixers, with a charging bin of 800 cubic yards capacity elevated above the mixers. The sand and rock brought in the dinky trains from the crusher plant are dumped into small receiving bins and elevated by motor-driven belt conveyors to the charging bin. Immediately below the charging bin are measuring bins, with a fixed choke feed and inlet gates operated by hydraulic cylinders. The gates from the measuring bins are also operated by hydraulic cylinders, the mixer man manipulating a three-way valve to move both gates. Adjacent to the receiving hoppers of the mixers are the cement measuring bins, which are filled from the weigher house, 180 feet above, through two 8-inch riveted steel pipes. Water for the mixers is to be pumped from the river into a 10,000 gallon tank on the adjacent hillside and the quantity for each charge measured in a steel drum mounted on the mixer.

The spouting system is used for placing concrete. A four-compartment elevating tower built of Oregon pine timber was originally constructed to a height of 180 feet and later extended to 350 feet. It is 10x27 feet in horizontal dimensions and is built up of four 10x12″ and four 10x10″ timbers, thoroughly sway-braced, and guyed with ¾″ cables at every forty feet of its height. Each compartment is equipped with a self-dumping one-yard steel skip. These skips are operated independently by single drum hoists driven by 100 H. P. motors, and are capable of a speed of

four hundred feet per minute. The concrete is distributed from the tower through two lines of 15″ Insley chutes, with a 50-foot main counterbalance and a 50-foot secondary counterbalance at the end of each chute.

Cement Storage and Transportation: All cement, except the relatively small quantity required for concrete blocks and miscellaneous small jobs, is delivered to the job in bulk. The box cars in which the cement is brought to the damsite over the Hetch Hetchy Railroad are emptied by means of an unloader consisting of a small motor-driven winch which drags a flat board scraper. The cement falls from the car doorway into a hopper, from which a twelve-inch screw conveyor takes it to a storage bin 150 feet away, which bin is 60 feet long, 32 feet wide and 34 feet deep, built with a V-shaped bottom, making the entire 13,000 barrels capacity (about 60 carloads) live storage. From the bin a 12-inch screw conveyor 120 feet in length carries the cement to a weigher house. This conveyor runs through a 4-foot by 6-foot tunnel beneath the storage bin. Slide trap doors are arranged along the sides of the tunnel to release the cement from the bin.

The weigher house is equipped with two 1200 pounds capacity scales with automatic feed and cutoff arrangements. Electrically operated signals, consisting of flash lights and horn sounders, and an independent telephone line, are installed to provide means of communication between the weigher house and the mixer house 180 feet below. Two eight-inch steels pipes on a one-to-one slope carry the cement from the weigher house to the cement measuring bins near the mixers.

Concrete Block Plant: Precast concrete blocks for the inspection wells and drainage wells, and precast screens, are manufactured at a separate concrete block plant, near the crusher plant, on the floor of Hetch Hetchy Valley. The

block plant includes a 1/3 cubic yard Smith mixer, storage bins for aggregate, cement storehouse, drying yard, steel collapsible forms and a wooden derrick operated by a steam hoisting engine.

Rock and Sand for Aggregate: Rock to be crushed for concrete aggregate, consisting of granite cobbles and small boulders, seldom exceeding one cubic foot in volume, is taken from a natural deposit near the foot of Falls Creek. This material is all hard, weather-worn stone, but is embodied in a deposit of sand and silt necessitating thorough washing in the crusher plant. A No. 70 Bucyrus steam shovel is used in the pit, and four-yard side-dump cars are used for transporting it to the rock crushing plant. Deep channels have been cut through the rock pit for handling the flood waters of Falls Creek, and an independent water supply has been piped from Falls Creek for use in the locomotives and steam shovel.

Sand is secured in a natural deposit in what is known as Rancheria Pit, located above the junction of Rancheria Creek with the main river at the upper end of Hetch Hetchy Valley. This pit consists of clean quartz sand, in a bank approximately 1200 feet long by 400 feet wide, and to a depth of thirty feet. In advance of building the railroad to this pit, test pits in the form of wells were dug to a depth of thirty feet and the quality of the sand thoroughly investigated and found satisfactory.

Electric Power:

In connection with the Contractor's operations at Damsite, electrical energy to the amount of 952,788 kilowatt hours was consumed during the fiscal year 1920-1921 and to the amount of 1,219,112 kilowatt hours during the fiscal year 1921-22. This is a monthly average for the two years of 79,400 and 101,593 kilowatt hours respectively. The maximum monthly consumption was 146,772 k. w. h. in June 1921. Power is used for oper-

ating pumps, rock crushers, concrete mixers, elevators, compressors, machine shop tools and miscellaneous machinery and lighting.

The power is furnished by the City's Early Intake power plant and charged to the Contractor at the rate of one cent per kilowatt hour.

Clearing Hetch Hetchy Reservoir:

The part of the Hetch Hetchy Reservoir basin not already cleared of trees and brush previous to the year 1919 is being cleared by the Utah Construction Company on a force account basis, as extra work under Contract No. 61. This work was commenced in April, 1921, and all timber is now cut. In clearing, 12,000 cords of wood were made. The cord wood is utilized in the construction work for steam shovel and locomotive fuel, and for firewood at the camps, thus greatly reducing the net cost of the clearing and saving the hauling of large quantities of coal or oil, or of wood from other localities. The area embodied in this recent clearing is approximately 900 acres, extending upstream from the dam for a distance of seven miles along the Tuolumne River, and including Little Hetch Hetchy Valley. Roads and trails were built, and camps to care for 120 men were established. A portion of the clearing was performed by using a steam driven winch to uproot the trees on the hillside. All refuse and grass is being burned, leaving a clean, bare surface in the reservoir basin.

Lake Eleanor Dam and Reservoir.

Lake Eleanor Reservoir is filled annually by the spring flood and later in the year, when the stream flow has fallen below the quantity of water necessary to operate the 4400 horsepower hydro-electric plant at Early Intake, water is released from storage to make up the deficit. During the late fall, the natural flow decreases almost to noth-

ing and the generators are operated entirely by means of stored water.

An attendant is stationed at the dam, whose duty it is to regulate the flow of water from storage according to orders from the chief operator at the power plant. He also reads the river gauges and keeps record of the quantity of water flowing at all times.

Clearing at Lake Eleanor: The falling of all standing timber in Eleanor reservoir was completed in December, 1921. Comparatively little clearing was accomplished during the fall and winter of 1920, as early heavy rains made it impossible to drain the water down to an elevation low enough to do much work. Due to heavy demand on our power plant last year, which resulted in almost complete depletion of the storage, it was possible to complete the clearing of the entire reservoir. The system used was to fall and burn all trees and brush, excepting large logs, which were not burned but are being put through the log chute in the dam, and will be burned below the dam.

The total area cleared in Eleanor reservoir is 513 acres, which, in addition to the natural lake area of 432 acres, makes a total area of 945 acres up to the contour at elevation 4660.

Lake Eleanor Creek Channel: To make it possible to utilize a few feet of the natural lake for storage of water, a channel 2200 feet long, twelve feet wide and from two to six feet deep, has been dug in the old channel of Eleanor Creek. This work was made necessary by the extremely low water and late fall of snow. On November 25th, 1921, the water had reached such a low stage as to require reducing the load on the power plant. The work of excavating the outlet channel was continued until December 18th, 1921, when an extremely heavy snowstorm made further work impossible and of no urgency.

Aqueduct in the Sierra Nevada.

The excavation of the aqueduct tunnels between Early Intake and the regulating reservoir at Priest, is proceeding under contract No. 77-C with the Construction Company of North America.

On July 1, 1920, five headings were being worked—Early Intake, South Fork East, Big Creek East and West, and Priest. During the next year work was begun on three more headings—South Fork West, and Adit 5-6 East and West.

In August, 1921, two headings from Adit 8-9 were opened, making ten headings which are now being driven.

The sinking of Second Garrotte Shaft was carried on continuously and the expected completion of the shaft in December, 1922, will give two more working faces in the aqueduct tunnel.

The tunnel aqueduct between Early Intake and Priest will be of two general types. The tunnel in hard tight rock will be unlined and will have a minimum cross sectional area of 167.8 square feet. The tunnel through soft or seamed rock will be concrete lined, having a finished cross sectional area of 87.94 square feet inside of the concrete. On both standard sections the hydraulic gradient when the flow is 400,000,000 gallons daily will be about 1.2 feet per 1,000 feet length.

Labor Difficulties: The tunnel work was seriously delayed during the year 1920, due to an outlaw strike called by the "Hetch Hetchy Miners' and Tunnel Workers' Union", a Local of the International Union of Mine, Mill and Smelter Workers. In July, 1920, this organization made demands for a new wage scale calling for an increase in the wages of machine drillers from $5.50 to $6.75 per day, and approximately the same amount of increase for the other classes

of tunnel workers. The existing scale was higher than on most similar work in California, including the mines in Tuolumne and neighboring counties. In view of this fact and the further consideration that, due to impossibility of disposing of bonds, funds were not available, the contractor refused the increase. On August 25, 1920, against the advice and orders of their own international officers, the tunnel workers' union went out on strike. The strike was confined almost entirely to the tunnel work, and the strike condition was ignored by all other crafts, notwithstanding that practically all of the skilled mechanics have union affiliations.

For 2½ months all tunnel work except pumping from the shafts was shut down. By the end of that time most of the strikers had left the vicinity of the work and only a few irreconcilables kept the strike idea alive. Following a favorable court decision on the legality of this contract rendering possible the financing of the work, the contractor began to assemble a new force, and in November work was resumed in four headings. Conditions then gradually returned to normal, though it was not until April, 1921, that the local agitators at last officially abandoned their efforts to hamper the prosecution of the work.

Summary of Progress for the Year:

The following table shows the progress in excavation of tunnels and shafts for the fiscal years 1920-1921 and 1921-1922, and total progress to June 30, 1922. The progress is illustrated graphically in the tunnel progress profile inserted after page 112 and the diagram on page 113.

Hetch Hetchy Aqueduct (Contract 77-C)
Progress of Excavation in Mountain Division Tunnels
(Total length of completed tunnels will be 96,768 ft.)

Heading	To be lined or unlined	Excavation in Feet: Previous to July 1, 1920	July 1, 1920, to June 30, 1921	July 1, 1921, to June 30, 1922	Total to June 30, 1922
Early Intake	Unlined	3860	2501	2772	9133
South Fork East	Unlined	4113	2072	3227	9412
South Fork West	Unlined	0	1943	3502	5445
Adit 5-6 East	Unlined	0	455	3580	4035
Adit 5-6 West	Unlined	0	387	3683	4070
Adit 8-9 East	Lined	0	0	3217	3217
Adit 8-9 West	Lined	0	0	3016	3016
Big Creek East	Lined	881	1429	4058	6368
Big Creek West	Lined	1266	2026	3857	7149
Priest	Lined	6078	3658	7298	17034
Totals—Feet		16198	14471	38210	68879
Miles		3.07	2.74	7.24	13.05
% of Whole Tunnel		16.7	15.0	39.5	71.2
Second Garrotte Shaft (depth)		352	116	220	686

(Total depth of this shaft will be about 820 feet, 84% completed to June 30, 1922.)

A brief description of the work at the individual working points follows:

Early Intake: Camp accommodations were improved by remodeling the cookhouse and making many minor changes in the bunkhouses. A new compressor was added to the tunnel plant.

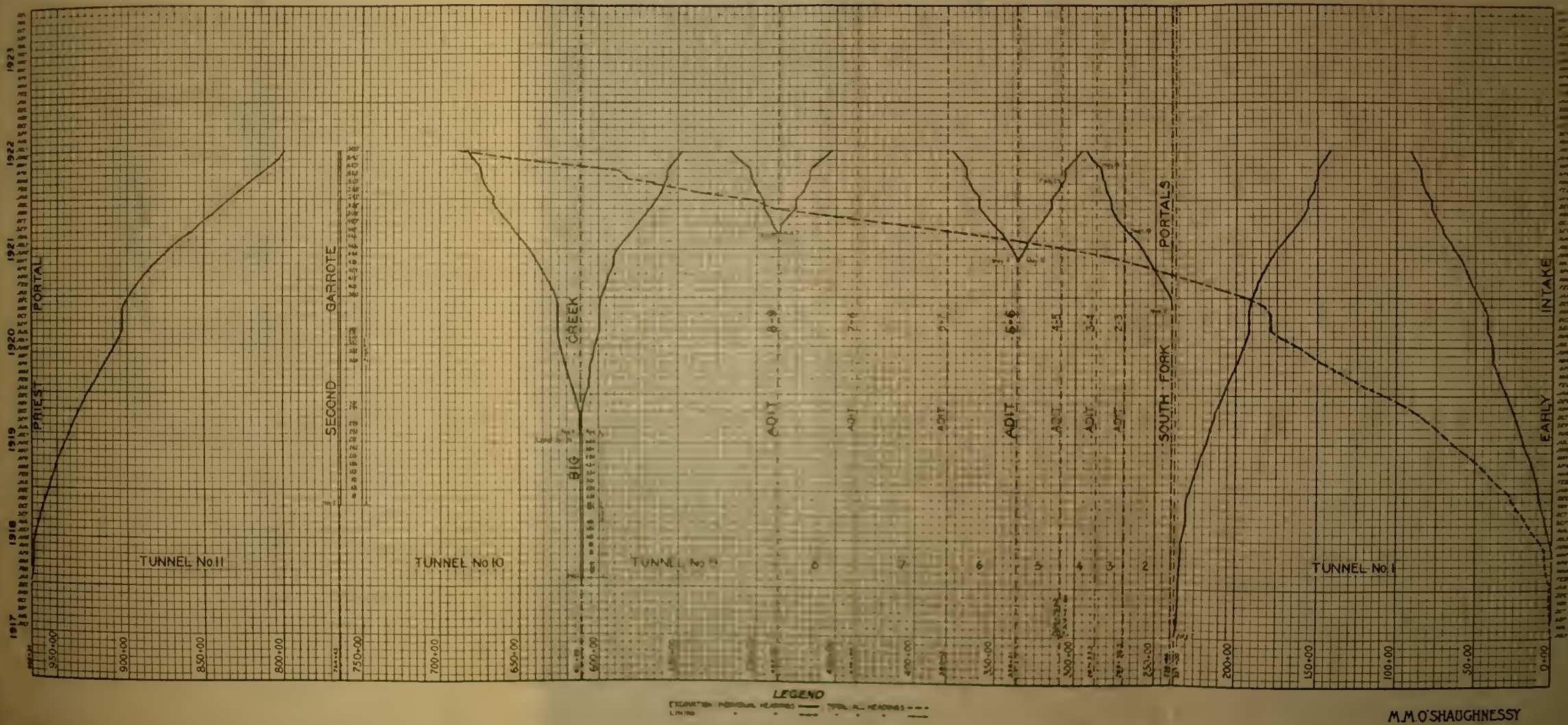
The tunnel is in very hard granodiorite, and will not be lined. The cross section is 13 ft. 4 in. wide and 13 ft. 6 in. high.

A brief interruption of progress was caused by striking an excessive amount of water in July, 1921.

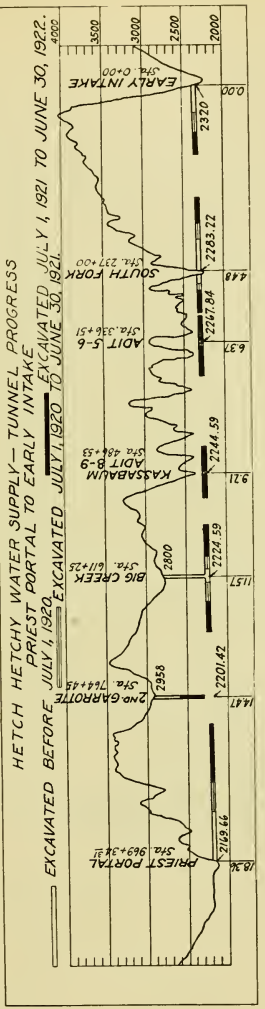
South Fork: The camp beside the railroad, which is a good twenty minutes' walk on a very steep road from the tunnel portals, was abandoned as a tunnel camp. A new camp was constructed in the South Fork canyon, close to the portals. The canyon is narrow, with very steep sides, and most of the buildings had to be strung out along the

HETCH HETCHY AQUEDUCT - MOUNTAIN DIVISION

TUNNEL PROGRESS CHART



M.M.O'SHAUGHNESSY
CITY ENGINEER


HETCH HETCHY WATER SUPPLY — TUNNEL PROGRESS
PRIEST PORTAL TO EARLY INTAKE
EXCAVATED JULY 1, 1921 TO JUNE 30, 1922.
EXCAVATED BEFORE JULY 1, 1920. EXCAVATED JULY 1, 1920 TO JUNE 30, 1921.
4000
3500
3000
2500
2000
EARLY INTAKE
Sta. 0+00
0.00
2320
SOUTH FORK
Sta. 237+00
2283.22
4.48
ADIT 5-6
Sta. 336+51
2267.84
6.37
KASSABAUM ADIT 8-9
Sta. 484+33
2244.59
9.21
BIG CREEK
Sta. 611+25
2800
2224.59
11.57
2NO. GARROTTE
Sta. 764+45
2958
2201.42
14.87
PRIEST PORTAL
Sta. 969+34.21
2169.66
18.36

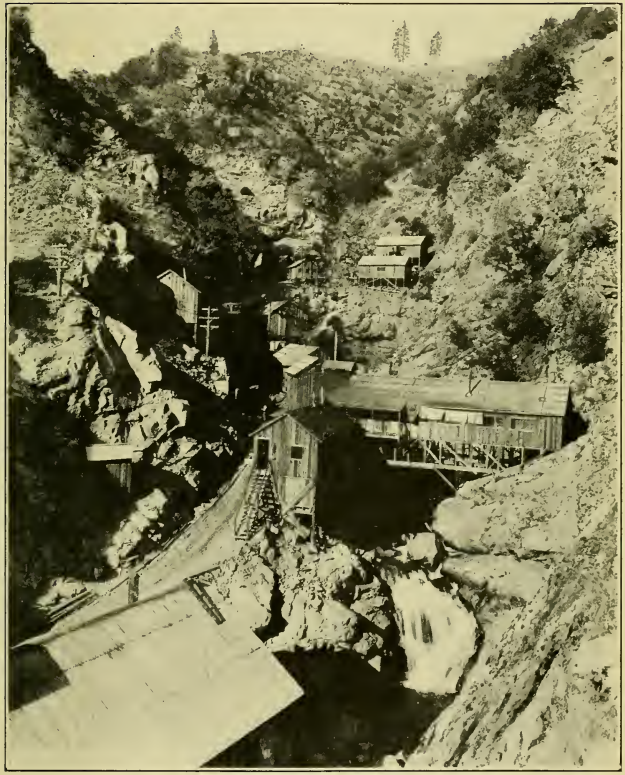
roadside. The cookhouse is supported on trusses across the river. This camp is known as South Fork Camp No. 2 or South Fork Portal Camp. The camp at the railroad, No. 1, is still maintained in part for railroad workmen and a few other employees.

A Cleveland tractor with crawler treads, weighing about 3450 pounds, was purchased for hauling over the road between the tunnel portals and the railroad station. This work was very severe for horses and destructive to rubber tires, on account of the heavy grade and the rough solid rock roadbed on which it is very difficult to maintain a good surface. The trailer used with the tractor is a sled on steel shod skids. The tunnel plant was enlarged by the addition of two compressors and a blower, and the plant buildings were remodeled. The road, plant and camp are on the east side of the river, and a timber bridge gives access to the west portal.

The muck from the tunnels is dumped directly into the stream channel. To avoid choking the waterway by dumping the muck from the west and east headings at opposite points, an adit 80 feet long was excavated extending northerly from the west heading and coming out a short distance downstream from the aqueduct crossing. During the flood season the river flows with such velocity in its very steep channel that a great deal of the accumulated rock from the previous year's excavation is washed out and carried on down stream, making room for that which will result from the next year's work.

The cross section of the tunnels in both directions from South Fork Portal is the same as at Early Intake, and the rock is very hard granodiorite.

The westerly tunnel from South Fork was commenced on November 17, 1920, and connected with Adit 2-3 on September 18, 1921, and with Adit 3-4 on May 18, 1922.



CAMP AT SOUTH FORK TUNNEL PORTAL, HETCH HETCHY AQUEDUCT CONSTRUCTION

The precipitous slopes of the canyon made it necessary to place most of the camp buildings along the road. The mess house spans the river.

Connection will be made westerly from South Fork to the easterly heading from Adit 4-5 during July, 1922. The water pipe line for Adits 5-6 and 8-9 will then be moved inside the tunnel, to prevent freezing during the coming winter.

In February, 1922, a rock slide from the canyon wall above the South Fork portal camp wrecked the boarding house, killing two men. This occasioned several weeks delay in the tunnel progress during reconstruction of the camp.

Adits: For 4.7 miles westerly from the South Fork crossing the aqueduct practically parallels the west canyon wall of the South Fork and the south wall of the main Tuolumne River canyon. The tunnel line is located far enough in from the surface to place the aqueduct in sound rock and secure sufficient covering at all points to resist pressure and reduce possibility of leakage from intersecting seams extending to the surface. Wherever such seams are found to occur concrete lining is to be resorted to.

In 1917, seven adits or short tunnels approximately at right angles to the general alignment of the aqueduct were driven from the canyon wall in to the tunnel line, to determine the nature of the rock underlying the surface and to give access to the work and provide additional working faces. The original adits were driven about seven by seven feet in cross section, by hand methods.

Economy in camps, roads and plant, together with the adoption of mechanical mucking machines and electric locomotives, were elements which led to the determination to carry on the tunnel from only two adits on this section called Adits 5-6 and 8-9. The other five are utilized as they are being intersected by the main tunnel, for ventilation and in some cases for dumping the excavated rock, thus shortening the length of air pipe from the blower to

the tunnel face and the distance the rock must be hauled from the face to the dump.

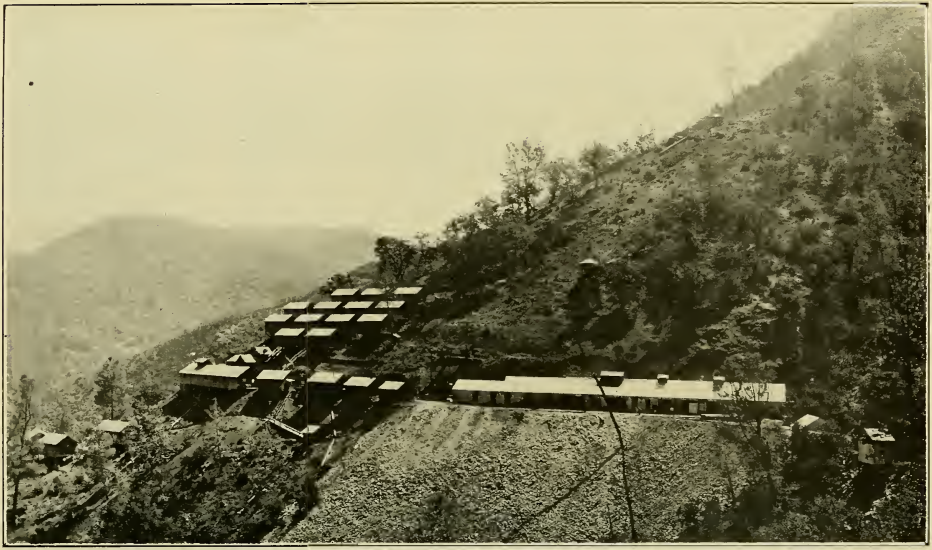
The few springs near Adits 5-6 and 8-9 are small, and to obtain sufficient water for the camps and construction work a line of four-inch pipe, 6½ miles long, was laid from the Middle Fork of the Tuolumne River, at a point just below the Hetch Hetchy Railroad crossing, from which the water flows by gravity to tanks at the adit camps. The necessary water could have been obtained with a much smaller length of pipe by pumping from the main river, but the expense of providing and operating pumps to raise the water against a head of over 500 feet, would have made the total cost of the pumped supply exceed that of the gravity supply from the Middle Fork.

Adit 5-6: All work accomplished here has been performed since the beginning of the calendar year 1921.

A road was constructed from the railroad station at Buck Meadows to the adit, utilizing as much as possible of the old road that leads down to the junction of the South Fork and the main Tuolumne River. The length of new road required was ¾ mile.

Camp buildings were erected, the office, cookhouse and dining room and bath house being located along the road, and the bunk houses placed on the steep hillside wherever most convenient. The camp will accommodate about 125 men.

The usual plant for excavating two headings was installed. The adit was enlarged in height and width to permit taking the mucking machines into the tunnel, and on May 10 and May 11, 1921, the excavation of the east and west headings, respectively, was started. The rock is granodiorite and of such character that the larger or unlined tunnel section was adopted. In the east heading the rock



CAMP AT ADIT 5-6, HETCH HETCHY AQUEDUCT CONSTRUCTION

The long white building contains the blacksmith shop, compressor plant, blowers and repair shops. Camp quarters and mess house at the left. Adit is in the small gully to the right of shop building.

becomes increasingly dense and the same cross-section is being used as at Early Intake and South Fork, 13 ft. 4 in. wide and 13 ft. 6 in. high, with the roof slightly arched. In the west heading, 740 feet from the adit, on account of the rock formation changing from monolithic to a massive blocky structure, the section of the tunnel was changed from the standard unlined section with flat arch to one with a semi-circular arch thirteen feet four inches wide and fourteen feet three inches high.

The latter section will be continued westward until the nature of the rock necessitates a lined tunnel.

On February 28, 1922, the east heading holed through to Adit 4-5, which is now used for dumping the muck and for ventilation, shortening the haul and length of vent pipe.

Adit 8-9: During the summer of 1921, a road 3 miles in length was constructed from Smith Station to Adit 8-9 and a camp was built near the adit. The camp now contains 22 bunkhouses, an office building and a mess hall, all of inexpensive construction. Air compressor, blowers, a charging set for storage battery locomotives, machine shop and blacksmith shop equipment were installed, practically duplicating the equipment of Adit 5-6. Two 10,000 gallon water tanks were erected to store water to supply the camp and tunnel work.

The original adit was enlarged to allow the Myers-Whaley mucking machines to enter the tunnel. The east and west tunnel headings from the adit were begun on August 25 and August 31, 1921, respectively. The formation is altered slate, and the tunnels are to be lined. The heading being driven westward from Adit 8-9 will connect with the Big Creek east heading in October, 1922.

In January, 1922, the water supply for Adit 8-9 was cut off by the freezing of the 4″ supply pipe which runs

from Middle Fork to Adits 5-6 and 8-9. Operations were continued with the use of the winter flow of the local gulches.

Big Creek: At Big Creek, two headings are being driven from Shaft Number One. The formation is metamorphosed slate and quartzite. The section here is to be concrete lined.

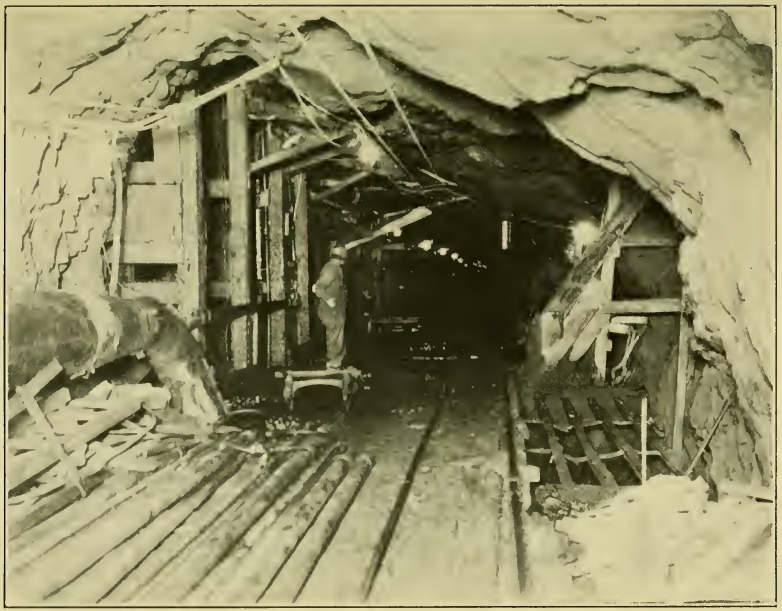
A small amount of water is encountered at intervals throughout the length of the tunnel. The water from the east end drains by gravity to the shaft and that from the west end is pumped from a series of sumps along the tunnel.

At the tunnel level, 575 feet below the collar of the shaft, the tunnel excavation is enlarged to about 16 feet in width for a length of about 120 feet for by-pass and double tracks and there are also recesses at the side for storing and repairing electric locomotives, mucking machines and cars.

Below the tunnel level there is a rock pocket with a capacity of about 3,000 cubic feet, into which the excavated material from both faces is dumped, through a rail grizzly, from the muck trains. Thence the material is discharged by gravity into the hoisting skips. A pump station is located at the level of the skip landing and the shaft extends to a further depth of 34 feet as a sump, the total depth from collar of shaft to bottom of sump being 646 feet.

At the surface the excavated material is dumped into a bin from which it is taken to a crusher nearby and crushed into sand and crushed rock for use in concrete lining of the tunnel. When needed, some of the waste is passed through a large gyratory crusher and is used for track ballasting on the Hetch Hetchy Railroad.

Second Garrotte Shaft: Shaft No. 2, near Second Garrotte, has been sunk to the 686-foot level. The formation



HETCH HETCHY AQUEDUCT TUNNEL AT BIG CREEK SHAFT

Tunnel section here is enlarged to make room for two tracks—normal tunnel section seen in the background beyond the switch. Timbering of 3-compartment shaft, which extends 71 feet below tunnel level, at the left. Rock from the tunnel face is dumped from muck cars over the grizzly bars at the right into a large storage pocket beneath the tracks and adjoining the shaft.

is diorite, with quartz seams. Progress has been slow at this shaft due to the heavy inflow of water, principally through the quartz seams.

At one stage of the work grouting under heavy air pressure was resorted to in an endeavor to cut off the inflow. The method used was to put down pilot holes in the shaft bottom, about 16 feet in depth. When water was encountered in the pilot hole, holes were drilled around the bottom of the shaft pointing outward at an angle of 30 to 45 degrees from the vertical. These holes were capped with 1½″ pipes and valves and grout forced into them under pressure ranging from 100 to 400 pounds per square inch (measured at the surface of the ground). This grout entered the seams of the rock and formed an impervious ring about the shaft, through which sinking operations were continued. Difficulty was encountered in carrying out this operation at times, due to the shattered character of the ground and also due to the cement being carried back into the sump during grouting, particularly in the open seamy ground, interfering with the operation of the pumps.

Greater pump capacity was secured and it was decided to buck the water on down. A flow of as high as 2,000 gallons per minute was handled at times, but the average was between 1,500 and 1,800 gallons per minute, and has gradually been decreasing.

To handle the water a series of pump stations have been excavated adjacent to the shaft at different levels and pumps have been installed. The water from the shaft above each of the stations is led into the station to avoid unnecessary pumping.

The geological formation in which this shaft is being sunk is conducive to difficult water conditions. Large seams in very steeply inclined planes intersect the shaft, and the water follows down the seams, reappearing below

the pump stations and necessitating handling practically all of the water from the bottom of the shaft.

Part of the water discharged from the pumps is used to supply water for all purposes to the town of Groveland.

It is expected that the shaft will have been sunk to tunnel grade by October, 1922, and allowing a month for the work of cutting a station, installing permanent pumps, etc., drifting in both directions will be started in December.

Priest Portal: The greatest progress in distance has been made driving east from Priest Portal, the westerly end of the 18.3 mile tunnel. In August, 1921, the workers at the Priest heading set an American hard-rock tunneling record of 776 feet for the month.

The formation generally is altered slate, which is good drilling and breaking ground. The material is quite hard and suitable for use in concrete. Portions of the tunnel have been through diorite and diorite is again being encountered from time to time.

No large amount of water has been encountered as yet and the small amount developed has caused no inconvenience, the grade of tunnel being downward towards the portal. As much of this water as is needed for domestic supply is passed through chlorination tanks and used at Priest Dam and Priest Portal camps. Water from this heading is also utilized for hydraulic sluicing at Priest Dam.

Rock excavated from the tunnel was dumped to form the downstream toe of the Priest Dam, but now practically all the rock excavated is being crushed by a sub-contractor into sand and rock and stored near the tunnel portal for use in the concrete lining of the tunnel.

Two accidents involving loss of life occurred during the year 1921-22 at this camp. Both were explosions at the face of the heading, caused by miners drilling into

"missed holes," i. e., unexploded blasting charges from the previous round.

Investigations by the Industrial Accident Commission absolved the Contractor, the Construction Company of North America, and the City and County of San Francisco of any blame in the matter.

Mechanical Equipment for Aqueduct Construction Work:

The service required of the machinery used in tunnel work is so severe that only the most rugged and least complicated types of equipment are suitable. In selecting equipment for constructing the aqueduct tunnels of the Mountain Division, the primary consideration was reliability, the next simplicity and economy in operation, maintenance and repair. Cheapness in first cost, while important, was relegated to third place.

Spare machines are kept on hand so that any machine can be taken out of service at any time for inspection and overhauling, or one in perfect condition can be substituted for one that has broken down, with little or no delay to the work. Each camp has its machine shop and blacksmith shop, a stock of spare parts, and a force of competent mechanics, prepared to repair or replace worn or damaged parts.

Careful attention to the selection and upkeep of the equipment has entirely eliminated serious delays due to breakdowns. The importance of continuous work will be realized on considering that the time of completion of the tunnels governs the time at which the Moccasin Creek power plant can be put in operation, and that the value of the power to be generated by the plant will be in the neighborhood of $5,000 per day.

Some of the principal items of mechanical equipment in use for tunnel excavation at the various working points are as shown in the following table:

Mechanical Equipment Installed for Aqueduct Construction

	Early Intake	South Fork	Adit 5-6	Adit 8-9	Big Creek Shaft	Second Garrotte Shaft	Priest
Number of headings being driven	1	2	2	2	2	Shaft	1
Air compressors, electric motor driven	2	3	3	3	3	2	3
Do. steam engine driven						1	
Positive blowers for ventilation, electric motor driven	1	2	2	2	2	2(a)	1
Do. air engine driven					1		1
Drill sharpening machine, pneumatic	1	2	2	2	2	1	1
Heating furnaces for drills, oil burning	1	2	2	2	2	1	1
Mucking machines, electric driven	2	3	3	3			2
Do. air driven					3		
Electric locomotives, 4 ton		1		3	3		4
Do. 5 ton	2	3	3				

(a) On hand, not yet installed.

Other equipment at individual plants will be mentioned later.

So far as economical and practicable, units have been standardized, so that like parts are interchangeable.

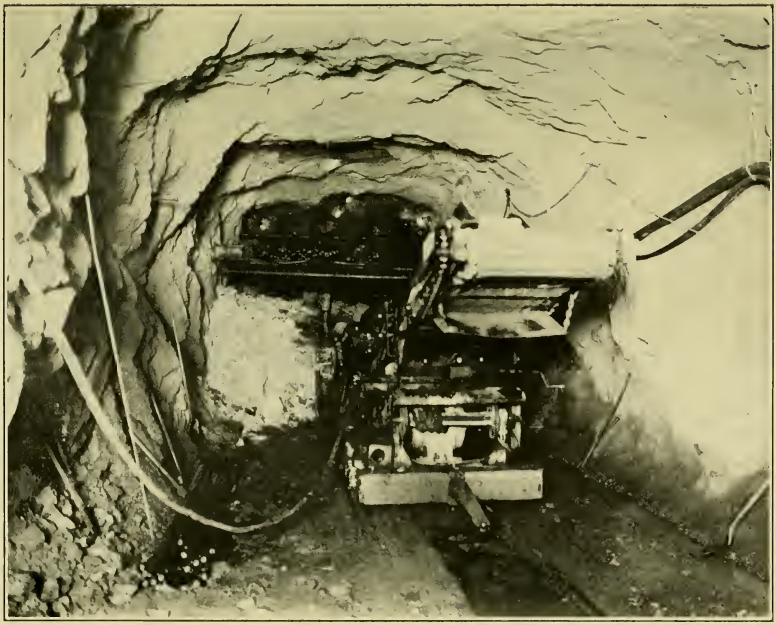
Air Compressors are of the cross-compound, belt-driven type, with short belt and tightener. Each compressor has its independent driving motor. Seventeen have a displacement capacity of about 670 cubic feet of free air per minute to 100 pounds gauge pressure, and are driven by 100-h.p. motors. There are two spare compressors at two plants which have a displacement capacity of about 500 cubic feet of free air per minute to 100 pounds gauge pressure, and are driven by 75-h.p. motors. The capacity of one compressor is sufficient for the needs of one heading; the second compressor, at a plant

from which one heading is being driven, or the third, at a two-heading plant, is a spare machine.

One compressor at Second Garrotte shaft is steam engine driven. This is an emergency machine for use in case the electric power supply should be interrupted.

Ventilation: Blowers for ventilation are all of the positive pressure type, with a displacement capacity of 4,500 to 4,700 cubic feet of air per minute to about 20 ounces pressure, and belt driven from 25-h.p. motors. Each blower is fitted with a "four gate system" for reversing the air current in the pipe to either "blow" or "exhaust." The ventilating pipe, in all but two or three faces, is 24-inch diameter 16-gauge riveted steel, in 19 ft. 7 in. lengths, made with butt ends and joined with bolted cinch bands. After riveting, the pipe and bands are dipped in hot asphalt. In the Priest Heading, the 24-in. riveted steel air pipe extends from the portal about 7,100 ft. into the tunnel, and the further extension to the face is 14-in. diameter wood stave pipe. To get proper ventilation through the smaller pipe a positive pressure blower operated by a direct-connected compressed air engine is installed near the face and the gases and impure air are blown outward through the pipe.

Mucking Machines are in use in all faces. These are simply mechanical shovels used to excavate and load into cars the broken rock resulting from blasting. Steam shovels driven by compressed air are ordinarily used for this purpose in large tunnels, but the size of the Hetch Hetchy Aqueduct tunnels limits the choice to the machines designed primarily for mines. Following the principle of standardization, Myers-Whaley electric motor driven mucking machines are used throughout, except at Big Creek, where the machines had to be let down through the shaft. Owing to the small size of the shaft compartments, small air operated mucking machines were used at this location.



TUNNEL FACE AT ADIT 8-9, HETCH HETCHY AQUEDUCT CONSTRUCTION

Platform and drills in place for drilling upper part of face. Myers-Whaley mucking machine in position for loading loose rock previously blasted out into cars to be hauled to the dump.

Haulage Equipment: The mucking machines load into side dump cars, of which there are about 100 of all steel construction, with a load capacity of 50 to 52 cubic feet each, and about 75 cars of wood and steel construction with a load capacity of about 80 cubic feet each. The steel cars are equipped with roller bearings in journal boxes. Other cars are fitted with renewable brasses in journal boxes. The rock is taken from faces in train loads of 5 to 8 cars. The track gauge in 24 inches.

Electric Locomotives: Electric storage battery locomotives are used for hauling the muck trains from the tunnel headings to the dump. The storage battery locomotive was selected in preference to the trolley type for several reasons, among which may be mentioned the elimination of the exposed trolley wire in the tunnel, which involves various hazards, such as shock, possibility of setting off powder through accidental grounding and resulting arc; further, the trolley involves more or less inconvenience, such as continually extending it as the tunnel progresses and moving it with the tracks on the dump. In this particular case, where the tunnel section is comparatively small and concrete lining operations will require the handling of the locomotive through the form work for the lining, the disadvantages of the trolley system would be very much accentuated.

The locomotives used are of two sizes, four and five tons respectively, the smaller being used in the 11′ 3″ tunnel section and the five ton in the 13′ 4″ section.

Big Creek Shaft Plant: This plant comprises the usual equipment for driving two headings, and in addition the necessary equipment for hoisting and pumping through the shaft.

The hoist is driven by a 150-h.p. motor connected through flexible coupling and gear reduction to the clutch

pinion shaft, operating double drums fitted with heavy post brakes.

The customary head frame with rock bin is installed at the surface and the shaft and head frame are equipped with two self-dumping skips and the necessary dumping apparatus at the bins at the top, and with loading apparatus at the bottom of the shaft. The rock pocket at the bottom and the bin at the surface are equipped with pneumatic-cylinder-operated rock-bin gates. Two-yard Western type dump cars hauled by mules convey the rock from the bins to the rock crushing plant or dump.

The pumping equipment at this shaft is as follows: two 3-stage centrifugal turbine pumps, each with a capacity of 800 gallons per minute and driven by a 200-horsepower motor, installed in the tunnel 180 feet east of the shaft, taking their suction from a sump in the tunnel and discharging to the surface; one motor driven centrifugal turbine pump, with a capacity of 250 gallons per minute, situated in the pump station at the skip loading level, 612 feet below the surface, takes its suction from the sump at bottom of the shaft and discharges to the surface; one motor driven, single stage, horizontal centrifugal pump with a capacity of 200 gallons per minute, installed at the latter pump station, discharges to the sump at the tunnel level (being used only when the other pump at this station is shut down or unable to handle the flow of waters); a small duplex pump discharges the water entering the west heading from the face to the tunnel level sump. The east heading drains by gravity to the same sump. The shaft is also equipped with a 350-gallon baling tank for emergency use.

Second Garrotte Shaft Plant: The plant at present comprises only the equipment required for shaft work. The hoisting rig is double drum, geared and driven by a 100-h.p. motor.

The head frame, dumping apparatus, rock bin, etc., at the surface are practically the same as at Big Creek, and the arrangement of rock pocket, pumping station, sump and storage space at the bottom of the completed shaft will be similar to that at Big Creek.

Large quantities of water (up to 2,000 gallons per minute) have been encountered in the Second Garrotte Shaft, necessitating pumps of much greater total capacity than at Big Creek

The fixed pumping equipment of the Second Garrotte Shaft consists of a centrifugal pump in a pump station at the 250 foot level, capable of discharging 600 gallons per minute to the surface, and a triplex plunger pump, also in this pump station, taking its suction from a separate sump and pumping 250 gallons a minute to the surface and thence to the Groveland water supply tanks, previously described. A ring at the 300 foot level intercepts additional water, which is pumped to the station by two 3-inch centrifugal pumps of 275 gallons per minute capacity each. In the second pump station at the 465 foot level are installed two three-stage centrifugal turbine pumps each of 750 gallons per minute capacity, pumping from a sump at the station direct to the surface through a 10-inch column pipe, and a two-stage turbine pump of 500 gallons per minute capacity, pumping to the upper station. A "slush" pump of 300 gallons per minute capacity pumps water intercepted by a ring at the 530 foot level to the pump station at the 465 foot level.

The sinking pumps include:

Centrifugal pumps—

Two 4″ 3-stage, 400 gals. per min., 400-ft. lift.

Two 5″ 2-stage, 650 gals. per min., 250-ft. lift.

One 7″ single-stage, 1500 gals. per min., 125-ft. lift.

All vertical pumps and each driven by direct connected 75-h.p. motor.

Cameron Sinking Pumps, air operated—

Three No. 7, capacity each 100 gals. per minute.

Two No. 93, capacity each 200 gals. per minute.

These pumps are not in use at present but are kept in reserve.

Air Lift—

One 7″, double leg, capacity 500 gals. per minute, using 1000 cubic feet of free air per minute.

This air lift is now used only as emergency protection for the upper station in event of failure of electric power.

Tunnel Lining:

As noted under Big Creek Shaft and Priest Portal, the crushing of rock and sand for the concrete tunnel lining has been carried on for some time and large amounts of these materials are now stored in stock piles ready for the concreting work. The crusher at Big Creek Shaft is now delivering an average of about 28 cubic yards of sand and 155 cubic yards of rock per day.

Equipment and Methods of Concreting: Orders have been placed for the special equipment for handling and placing the concrete and for the collapsible lining forms and travelers for this work.

For placing the concrete in the tunnel linings "Universal" pneumatic concrete guns are to be used. The concrete gun consists primarily of a cylinder of 10 cubic feet capacity into which the mixed concrete charge is placed from dump cars. The material is forced out of the cylinder into a discharge pipe by a pneumatically operated piston, and is conducted through suitable piping to the forms. The gun will be placed in the tunnel, close to the forms. Where the distance from the portal to the forms is short, the concrete will be mixed outside the tunnel and hauled in the cars by the storage battery locomotives to the gun, but where the haul is long, it will not be desirable to transport wet concrete from the portal to the gun. A special portable mixing plant has

been designed, which will travel on the tunnel track. Cement, rock and sand will be mixed dry at the tunnel portal and then hauled to the portable mixer, which will keep close up to the concrete gun. The latter mixer will mix the dry ingredients and the water and discharge into the concrete gun.

Forms for the concrete tunnel lining are being furnished by the Blaw-Knox Co. of Pittsburgh. The forms are in sections, each 20 feet long, and are built up of steel framework and wooden covering. They are collapsible, the collapse being effected by means of three hinges located at the top and in the sides. The entire form will be moved ahead in the tunnel on a carriage or "traveler," which will run on the 24-inch gauge track already in place in the tunnel. Eight hundred feet of tunnel forms and two travelers have been ordered.

Early Intake Diversion Works.

Two sites have been under consideration for some time as available for the diversion dam on the Tuolumne River at Early Intake. During the winter of 1921-22, eight diamond drill holes were bored to determine the depth to sound bedrock at these two sites. On comparing the foundations and the preliminary designs for the structures, the upper site was definitely selected.

The design of the dam is now in preparation. As at present contemplated, it will be an arch dam of thin section on a short radius, the length along crest being about 200 feet, and the total height about 85 feet from top of dam to bottom of excavation. The spillway will have a capacity of 20,000 cubic feet per second. The dam at the upper site will be shorter and will require considerably less excavation and concrete than would be necessary for the lower site.

A tunnel will extend part of the way from the diversion dam to the main tunnel portal, and the remainder of the connection will be made by a closed concrete conduit built on a bench excavated on the side hill.

Moccasin Creek Power Development.

Lands to the extent of 162.91 acres in the valley of Moccasin Creek, necessary for the power house and appurtenant structures, were purchased. Condemnation proceedings had already been instituted by the legal staff of the Hetch Hetchy Water Supply, but the matter was settled out of court before the case came to trial.

In the fall of 1921, construction was begun on a camp near Priest Portal, to house the men constructing Priest Dam and the power outlet tunnel which will connect Priest Reservoir and the upper end of the penstock line of the Moccasin Creek power plant. This camp has a capacity of about 300 men.

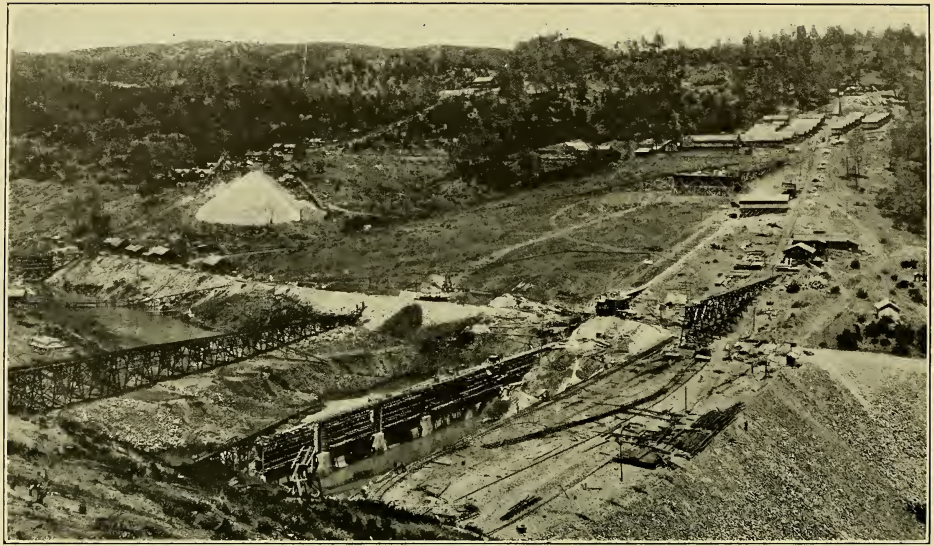
Another camp accommodating 300 men has been established on the property purchased in the valley of Moccasin Creek. The cookhouse, dining room and appurtenant structures are of standard lumber construction, while the sleeping quarters are tents.

A camp is contemplated at the west portal of the power tunnel. The men living at the west portal will be principally the miners working in the tunnel and the force constructing the tramway and the upper end of the penstock.

Priest Earth Dam:

Upon completion of the final plans of Priest Dam, a revolving steam shovel of the caterpillar type, two 20-ton dinky locomotives, and a complement of 24 4-yard cars were put into service to construct the fills for the dam and to excavate the approach to the power tunnel. Equipment was also installed to sluice material from the adjacent hillsides and place it to form the upstream portion of the dam.

The dam, as at present being built, consists of a central concrete core wall to bedrock, an earth fill downstream



PRIEST DAM AND RESERVOIR, MOCCASIN CREEK POWER DEVELOPMENT

(June 28, 1922.) At the right is the downstream earth fill embankment formed by the dump from Priest heading of the tunnel and from steam shovel excavation in adjacent hillside. Upstream is the concrete core wall and further upstream the flume on a trestle, through which material hydraulically sluiced from the adjacent hillside is transported to form the upstream embankment.

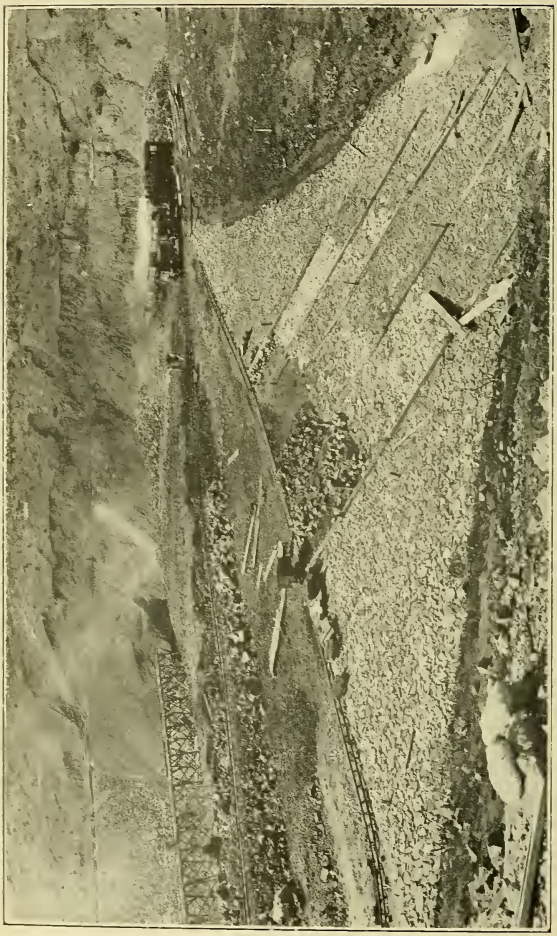
embankment with rock fill toe formed by the spoil from the Priest Tunnel heading, and an earth fill upstream embankment, the greater part of which is placed by the hydraulic fill method. The upstream toe will be paved with rip-rap. The crest of the dam will be at elevation 2,245, the length along crest will be 1,100 feet, and the length from upstream toe to downstream toe 700 feet.

The capacity of Priest Reservoir will be 800 million gallons or 2,500 acre feet. For draining the reservoir and to provide an outlet for the natural drainage during construction, a 6-foot diameter tunnel, 900 feet long, has been excavated through rock formation on the east abutment. This tunnel is being lined with concrete. Two sets of two 30-inch valves in tandem, for controlling the water, will be installed in the tunnel at the bottom of a vertical concrete lined shaft and tower. The operating mechanism will be at the top of this shaft.

Power Tunnel and Penstock:

The water from Priest Reservoir will pass to the Moccasin Creek power plant through the power outlet tunnel, which will have a horseshoe section 13 feet in height and width inside of lining. This tunnel will be 6,200 feet long, and at its westerly end the water will enter pipes, dividing finally into four lines, one for each unit. The length of pipe from the tunnel to the power house will be 4,950 feet. The penstocks will pass under the Hetch Hetchy Railroad at the east switch of Cavagnaro siding.

Grading for the penstock line will begin shortly. The pipe sections will be distributed along the line of penstock by a tramway, the principal point of delivery for the pipe being Cavagnaro siding. Machinery and materials for the power house will be delivered over a spur from the Hetch Hetchy Railroad now being constructed. Yard tracks are to be constructed at the power house.



PRIEST DAM, MOCCASIN CREEK POWER DEVELOPMENT.
View of upstream toe, showing riprap paving placed as a precaution against damage by wave wash.

Power Plant:

The power plant machinery is ultimately to comprise six main generating units with auxiliary apparatus. These units will be 20,000 kv-a 11,000-volt electric generators with direct connected exciters, each driven by two impulse waterwheels aggregating 25,000 horsepower capacity, overhung on the shaft on opposite sides of the generator. The speed will be 257 revolutions per minute. The effective head of water at the waterwheel nozzles will be 1,250 to 1,275 feet when operating under full load.

The contract for furnishing and delivering the waterwheels for driving the four 20,000 kv-a generators, which will constitute the initial power installation, was awarded on April 28, 1922, to the Pelton Waterwheel Co. of San Francisco. Bids were received from two manufacturers on several alternate propositions, which varied as to the number, weight and speed of waterwheels to be furnished. The bids for four units as described above were:

Pelton Waterwheel Co.	$248,800
Allis-Chalmers Manufacturing Co.	303,500

The contract for the four main generators and the motor-generator exciter set was awarded on the same date to the General Electric Co. Three manufacturers bid on various alternate propositions, the bids for the machinery as described above being as follows:

General Electric Co.	$260,285
Westinghouse Electric & Manufacturing Co.	304,695
Allis-Chalmers Manufacturing Co.	$302,515 and 313,110 (Two propositions.)

There will be 13 main line transformers rated at 6,667 kv-a each. They are to be water cooled and oil insulated, and installed out of doors. Three will be connected with each generator, and one will serve as a spare unit.

Hetch Hetchy Railroad.

The Hetch Hetchy Railroad is operated as a common carrier, transporting freight, passengers and United States mail between Hetch Hetchy Junction and Damsite. Trains are operated on regularly established schedules for both freight and passenger travel.

Freight Haul:

The placing of the concrete at Hetch Hetchy Dam, beginning in the early fall of 1921, has resulted in a very heavy increase of freight traffic on the railroad, the delivery of cement to Damsite alone reaching a peak load of 2,000 barrels a day in the early summer of 1922. In addition to this business, there has been a largely increased haul due to greater activity in the tunnel work. The great bulk of freight hauled is of course for the Hetch Hetchy construction work, but the hauling of lumber from the California Peach and Fig Growers Association's mill at Mather and other local business has also increased. The South Fork Lumber Co. has begun the operation of the old Heardin sawmill on the South Fork of the Tuolumne River and is hauling the lumber five miles from the mill to South Fork Station for shipment. Yard changes were made at the station to accommodate this business.

Passenger Traffic:

Passengers are carried on a mixed train each day between Hetch Hetchy Junction and Damsite, and by track busses operating twice daily on schedule between Groveland and Damsite. Since the inauguration of mixed train service between Groveland and Hetch Hetchy Junction, there has been a marked increase of business, especially during the winter time, when rail travel is preferable to auto stage. This is in spite of the fact that the railroad fare between

Groveland and Stockton is 75 cents in excess of the stage fare.

The one-day trip operated by the Yosemite Transportation System from Yosemite to Hetch Hetchy and return has been more popular with summer tourists than in previous years. They are brought by auto stage from Yosemite Valley to Mather, at which point they change to the railroad for the nine-mile trip to Damsite, where approximately two hours may be spent before starting back to Mather. During the height of the 1921 vacation season the number of tourists taking this trip averaged over 60 per day. Although in 1922, due to the Big Oak Flat road being closed by snow until unusually late in the season, tourist service did not begin until June 19, for the first few weeks the number of tourists per day averaged well over 80. The City receives $1.50 each for its part in transporting them.

The City of Oakland in 1920 established a municipal recreation camp on the Middle Fork of the Tuolumne River, where its citizens can enjoy an outing at a reasonable expense. The precedent was followed, in the spring of 1922, by Berkeley, which instituted the "Berkeley Mountain Camp" near Heardin Ranch on the South Fork of the Tuolumne, about five miles above South Fork Station of the Hetch Hetchy Railroad. Both of these camps have been well patronized this year, there being at times at the Oakland camp as many as 250 people, while the Berkeley camp has had nearly 200 people. In previous years, persons coming to the Oakland camp have been transported by motor truck, the trip taking two days, and requiring a stop over night at Knights Ferry. This year they elected to travel by rail, the total fare from Oakland to the camp being $11.25 for the round trip, and as many as 125 of these campers have been handled on one trip. The crowds have been transported with very little difficulty. Bi-weekly excursions have been run from their camps to Hetch Hetchy Dam.

United States Mail:

In September, 1921, the Hetch Hetchy Railroad began carrying mail under United States Government contract to and from Big Oak Flat, Groveland, Buck Meadows, Mather and Hetch Hetchy postoffices. In June, 1922, a postoffice was established at Oakland Recreation Camp, mail being handled via South Fork Station.

Ballasting:

To June 30, 1920, about 50 miles of the railroad had been ballasted. The work of ballasting was continued on the remaining 18 miles, using gravel from the pit at Mather, and was completed in the spring of 1921. This terminated the original construction of the railroad. Some ballasting work is being continued in connection with the regular maintenance of the track and roadbed. This consists in completing the work at some of the light sections and reinforcing weak spots. About 5 miles of track was thus reballasted between Moccasin Creek and Groveland, where the original ballast of disintegrated granite has proven unsatisfactory. For this purpose the schist and quartzite rock obtained from the aqueduct tunnel excavation at Big Creek shaft is being used. A rock crushing and screening plant was erected beside the track. The rock intended for use as ballast, after passing the crusher and screens, falls into storage bunkers, from which it is loaded when desired into the dump cars to be conveyed to the points where the section gangs are at work. Big Creek is near the halfway point between the two ends of the railroad. The cost of hauling the ballast is small, as it is generally possible to attach a car to an unloaded westbound train or to a comparatively light train going east.

Winter Conditions:

The winter of 1921-22 was exceptionally heavy and taxed the resources of the maintenance crews to the utmost

to keep the road open. During the seven days before Christmas ten feet of snow fell at Summit and only the use of a new snow plow, which had been lately constructed in the Groveland shops, prevented actual blocking of the railroad. Heavy slides in the vicinity of South Fork seriously threatened to interrupt traffic. It is probable that the roadbed has now settled to such a stable condition that in the future no winter, however severe, will cause serious interruption to traffic.

New Construction:

The following new stations, sidings and spurs have been or are now being constructed:

Smith Station—A station and warehouse building from which freight for the aqueduct construction work is transported by motor trucks to Adit 8-9.

Buck Meadows—A station and warehouse building for similar service to Adit 5-6.

Priest Dam—A three-car siding with a spur on a trestle, the latter being required to handle sand brought from the Munn sand plant.

Chrome—A five-car spur on which to deliver lumber and other materials for construction of Moccasin Creek Camp. A small warehouse was also erected.

Moccasin—A 20-car siding and a one-mile spur for the purpose of switching and delivering freight for the Moccasin Creek Power House. This spur leaves the main line near Mile 15 and descends to the power house on a uniform grade of 5 per cent and a maximum curvature of 30 degrees.

Munn Sand Plant—A 10-car spur for loading sand and rock for Priest Dam and Moccasin Creek Power House.

Pedro Siding—The old siding at West Branch was moved to the top of the grade west of the Tuolumne at Mile 4, to facilitate handling heavy eastbound trains. This siding

has trebled the capacity of locomotives operating from Hetch Hetchy Junction to Munn Station, as the capacity of an engine from the new Pedro siding to Munn is about four times its capacity from Hetch Hetchy Junction to Pedro, due to the difference in grades.

Hetch Hetchy Junction—A crossover was constructed between the Sierra Railway tracks at Hetch Hetchy Junction and the Hetch Hetchy Railroad yards, permitting much readier yarding of cars than under previous conditions.

Line Change at Sixbit Gulch—The Don Pedro Dam, at present under construction by the Turlock & Modesto Irrigation Districts, will back water over the Sixbit trestle of the Hetch Hetchy Railroad as now in operation. It has been agreed upon between the City and the Irrigation Districts that this trestle shall be replaced by a steel bridge on concrete piers at an elevation about 15 feet higher than the trestle. The cost of this work will be borne by the Irrigation Districts, except that the City will allow $6,300 as the value of its use of the old trestle before the building of the bridge. Contracts for the work are now prepared and bids will be received shortly.

Rolling Stock:

The railroad now owns six locomotives. A 101-ton Shay locomotive was purchased in the spring of 1922, and was put in service on the slow haul of cement.

Two coaches were purchased to handle excursions and large parties of tourists. Two of the gondola side dump ballast cars, purchased to complete the ballasting from Buck Meadows Gravel Pit two years ago, were rebuilt into open observation cars of 77 passengers capacity. The wrecker, the construction of which was started last year, was changed to a standard 100,000 pounds capacity flat car.

One of the White two-ton freight trucks, which was wrecked in a collision, is being rebuilt as a passenger motor

car in Sacramento. The motor and radiator are to be put on the extreme rear end of the car, the driver being seated in front on the right side. The car will have a normal seating capacity of 20 and has removable seats to accommodate 12 more persons. The center of gravity is being kept very low, to prevent excessive wheel wear and to decrease the sway on curves while running at high speed. The total height of the car from top of rail is only 7½ feet. This car is equipped with a 20-45 White motor, and is expected to make over 20 miles an hour up 4 per cent grades with a full load of passengers.

The other White two-ton freight truck has been reconverted into an ordinary road truck for general hauling.

A Pierce-Arrow truck has been equipped with tools and supplies necessary to fight forest fires, and is kept in readiness at all times, so that the Fire Warden may go quickly to fires along the right of way upon short notice. It appears to be impossible to prevent starting grass fires from time to time, and the only method of coping with them is the immediate dispatch of men at the time a fire is reported.

Hetch Hetchy Railroad Rolling Stock.

Locomotives.

No.	Make.	Type.	Weight.	Year of Purchase.
1	Heisler	8 wheels, geared	57 tons	1916
2	''	12 '' ''	75 ''	1917
3	Baldwin	Mikado (2-8-2)	83 ''	1917
4	American	'' (2-8-2 S)	92 ''	1919
5	''	Prairie (2-6-2 S)	64 ''	1921
6	Shay	12 wheels, geared	101 ''	1922

Passenger Train Cars.

Passenger coaches, 44′ 11″ long, seating capacity 52	2
Excursion observation coaches, 39′ 6″ long, seating capacity 77	2
Combination baggage and passenger coach, 58′ long, seating cap. 40	1
Total passenger cars	5

Freight Train Cars.

Class.	Length Feet.	Weight Pounds.	Capacity Pounds.	Number Owned.
Flat cars	34	22,000	60,000	6
" "	40	24,500	60,000	4
" "	40	29,000	80,000	1
" "	41	33,000	100,000	1
Total flat cars				12
Box cars	33	25,000	40,000	6
" "	35	26,000	40,000	1
" "	35	28,000	50,000	1
" "	36	32,000	60,000	4
Total box cars				12
Gondola cars, center dump	39	33,900 to 37,400	80,000	8
Gondola cars, side dump	39½	68,500	100,000	2
Air dump cars	27	29,400	12 cu. yds.	4
Total gondola and dump cars				14
Caboose cars	24	20,000	30,000	3
Total freight train cars				41

Railroad Service Cars.

Class.	Length Feet.	Weight Pounds.	Capacity Pounds.	Number Owned.
Steam shovel		80,000		1
Snow plow	30	60,000		1
Tank car	34	20,000	40,000	1
Total railroad service cars				3

The gondola and dump cars are used in hauling gravel and crushed rock for ballasting the railroad track, and will also be used to transport sand and crushed rock for tunnel lining and other concrete work. They may be considered freight train cars or railroad service cars, according to the class of service in which they may be in use at any time.

The tank car is used in connection with steam shovel operation, to supply oil and water to the shovel. It is a flat car on which have been mounted two steel tanks having capacities for 2,325 gallons of water and 1,800 gallons of oil respectively.

Gasoline Motor Equipment.

Class of Service.	Make.	Capacity Passengers.	Capacity Tons.	Number Owned.
Passenger	Pierce-Arrow		2	1
	White	13	¾	1
	"	23	2	1
	"	27	2	2
	"	32	2	1
Freight	Pierce-Arrow		2	1
	Packard		3½	1
Railroad service, fire patrol	Pierce-Arrow			1
Total motor cars				9
Motor-driven section cars (speeders)				9

Operating Schedules:

The nature of the passenger service provided by the Hetch Hetchy Railroad is shown by the accompanying time table. Through service is given daily in the summer between Hetch Hetchy Junction and Damsite, connecting with the Sierra Railway, so that a person leaving San Francisco in the morning can reach Hetch Hetchy Valley (Damsite station) in the evening of the same day, and vice versa; in the winter a different schedule is put into effect and the passenger must break his journey between San Francisco and Damsite by making an overnight stop at Groveland.

HETCH HETCHY RAILROAD
Time Table No. 9

EASTWARD—Read Down
In effect May 1, 1922, at 12:01 A. M.

WESTWARD—Read Up
Subject to change without notice

4	6	2	Miles	STATIONS	Elev.	1	5	3
		2:45 p.m.	0	Lv. Hetch Hetchy Junction	Ar. 936	8:30 a.m.		
		f 3:08 p.m.	7	Sixbit Gulch	Lv. 600	f 8:08 a.m.		
		f 3:25 p.m.	12	Munn Tank	672	f 7:52 a.m.		
		f 3:45 p.m.	17	Cavagnaro	1458	f 7:25 a.m.		
		f 4:10 p.m.	23	Priest Portal	2470	f 7:04 a.m.		
		s 4:40 p.m.	27	Ar. Groveland	Lv. 2777	6:45 a.m.		
8:30 a.m.	7:30 a.m.	5:00 p.m.	27	Lv. Groveland	Ar. 2777	s 6:30 a.m.	s 4:00 p.m.	s 4:35 p.m.
8:50 a.m.	s 7:52 a.m.	f 5:22 p.m.	33	Big Creek	Lv. 2740	f 6:08 a.m.	s 3:38 p.m.	4:10 p.m.
9:00 a.m.	s 8:00 a.m.	f 5:30 p.m.	35	Smith	3018	f 6:00 a.m.	s 3:30 p.m.	4:02 p.m.
9:20 a.m.	s 8:15 a.m.	s 5:45 p.m.	39	Buck Meadows (b)	3060	s 5:45 a.m.	s 3:10 p.m.	3:45 p.m.
	f 8:24 a.m.	f 5:55 p.m.	42	Colfax Gate	3120	f 5:35 a.m.	f 3:05 p.m.	
s 9:50 a.m.	s 8:33 a.m.	s 6:03 p.m.	44	South Fork	2875	s 5:25 a.m.	s 2:55 p.m.	s 3:25 p.m.
	f 8:54 a.m.		50	Jones	3810		f 2:34 p.m.	
10:30 a.m.	s 8:58 a.m.	f 6:28 p.m.	51	Intake	3897	f 5:00 a.m.	s 2:30 p.m.	2:50 p.m.
s11:00 a.m.	s 9:25 a.m.	s 6:55 p.m.	59	Ar. Mather	Lv. 4520	4:35 a.m.	2:00 p.m.	2:15 p.m.
7:30 a.m.	June 1 to		0	Lv. Yosemite Valley (Y.T.S.)	Ar.	June 1 to	5:45 p.m.	
11:00 a.m.	Oct. 1		33	Ar. Mather	Lv.	Oct. 1	2:00 p.m.	
11:15 a.m.	9:30 a.m.	7:00 p.m.	59	Lv. Mather	4520	s 4:30 a.m.	s 1:50 p.m.	s 2:00 p.m.
	9:38 a.m.		62	Summit	5064		1:40 p.m.	
s12:00 m.	s10:00 a.m.	s 7:30 p.m.	68	Ar. Damsite (Hetch Hetchy)	Lv. 3869	4:00 a.m.	1:15 p.m.	1:20 p.m.

(b) Passengers for Bower Cave may secure transportation to or from Buck Meadows through arrangement with Hetch Hetchy Railroad Station Agents.

ABBREVIATIONS: s Regular Stop. f Trains stop on signal only. Ar. Arrive. Lv. Leave.

Owing to limited space, the Railroad does not guarantee immediate transportation of baggage on motor cars.

Connections at Mather to Yosemite Transportation System's "Tioga Pass Route" between Yosemite and Tahoe.

Trains No. 1 and 2 connect with Sierra Railway, Southern Pacific and Santa Fe Railways.

Trains No. 1, 2, 5 and 6 arrive at and depart from passenger depot at Hospital Road Crossing, Groveland.

Trains No. 3 and 4 arrive at and depart from Freight Shed

L. T. McAFEE, SUPERINTENDENT

L. B. CHEMINANT, ASST. SUPT. & TRAINMASTER

Munn Sand Plant.

At Munn Station on the Tuolumne River a sand plant has been erected. Sand from the banks of the river is scraped to a bucket conveyor, raised to revolving screens, washed and sized, and the resulting clean sand is transported in cars for concreting purposes. Sand is being hauled from this plant to Priest Dam for the construction of the concrete core wall, at the rate of about 50 yards per day. Upon completion of the core wall, sand will be hauled to Moccasin Creek Power House for concrete work. Plans are now being made to save the rejected gravel for use for concrete at the power house.

Mather Sawmill.

The City's sawmill, situated at Mather on the Hetch Hetchy Railroad, thirty-two miles east of Groveland and nine miles west of Hetch Hetchy, has been operated throughout this period, except a few months during the winters, cutting lumber and timber for use on the Hetch Hetchy project.

The products of the mill are used for camp buildings, bunkers, railroad ties, tunnel timber, forms for concrete work, and many other features of the construction work. Slab wood is furnished to a few of the camps for fuel and is also used for steaming fuel at the sawmill itself. The sawmill is the only steam-operated plant on the Hetch Hetchy system, steam being preferable on account of affording an opportunity to burn the slabs.

Improvements made during the past year include the installation of a new carriage with low improved head blocks, a sawdust burner and the establishment of a yard for clear lumber. Also, a new large logging donkey engine has been purchased. During April, 1922, a new log chute was built, as previous to the winter shutdown all timber available with the old chute had been cut.

SAWMILL AT MATHER, HETCH HETCHY WATER SUPPLY PROJECT

Mill is steam operated and has a capacity of 25,000 board feet per 8-hour shift. Lumber manufactured for forms, tunnel timbering, flumes, ties, buildings, etc., on the project.

Additional timber land to the amount of 160 acres has been contracted for adjacent to the City's holding at Mather.

The capacity of the mill is 25,000 feet board measure per eight-hour shift.

The output of the Mather Sawmill for the past two fiscal years was as follows:

Output of Mather Sawmill.

		—Fiscal Year— 1920-21	1921-22
Lumber manufactured (log scale)	Bd. ft.	2,836,130	3,789,032
Lumber surfaced	Bd. ft.	381,162	620,087
Lumber shipped to the construction work	Bd. ft.	2,750,818	4,208,785
Lumber on hand at mill at end of fiscal year	Bd. ft.	450,000	238,537

In July, 1921, a trade arrangement was made with the California Peach Growers' Association whereby the City receives for its choicer grades a greater amount of common Douglas fir on the following basis:

Clear sugar pine, wide stock	3 for 1
No. 3 sugar pine, narrow stock	2¼ for 1
Shop sugar pine, containing knots	1¾ for 1
White pine, No. 3, clear and better	1¾ for 1

Due to the trade basis, the mill has been able to ship 187,967 board feet more than it actually manufactured.

The total quantity of lumber manufactured to date at the City's former mill site at Canyon Ranch and the present site at Mather is as follows:

	Board Feet.
Canyon Ranch	6,321,816
Mather	8,223,838
Total	14,545,654

Lower Cherry River Power Development.

The rated capacity of the Early Intake Power House built to supply construction power is 2,400 k.w. at 80 per cent power factor. The total connected step-down transformer capacity for power and lighting purposes at the various camps, as of June 30, 1922, is 6,740 kv-a. Of this total 160 kv-a. are at the Early Intake camp, 2,315 kv-a. are easterly from the power house, and 4,265 kv-a. westerly. Branch transmission lines were built to Adits 5-6 and 8-9 and a substation of 310 kv-a. built at each of these camps. A line from Priest Camp to Moccasin Creek was completed and put in service on June 23, 1922. The transmission lines now connect to 14 points on the Hetch Hetchy work, and to the Pacific Gas & Electric Company's lines at points near Priest Camp and Pedro Siding.

Capacities of Substations
June 30, 1922.

Camp.	Capacity, KV-A.
Damsite No. 1	1210
" No. 2	750
" No. 3	225
Mather	130
Early Intake	160
Intake Siding	100
South Fork Portal	385
Adit 5-6	310
Adit 8-9	310
Big Creek	770
Second Garrotte	750
Priest	1395
Moccasin Creek	160
Groveland	75
Total, all substations	6740 KV-A

During the past year the power demand for the construction work has been such as to tax the power house to capacity. When the plant was first placed in service in the year 1918, power required for the construction work on the project was but a fraction of the plant capacity. At that

time there was a statewide power shortage. The Power Administrator, Mr. H. G. Butler, ordered that a connection be made between the City's transmission line and the system of the Sierra & San Francisco Power Co. near Priest Camp in order that this surplus generating capacity be utilized toward the relief of the serious power shortage throughout the State. The connection made under this order has been maintained and has not only enabled the City to dispose of the surplus power but has also made available a source of power for standby in emergencies. During the past two years the project has received from the Pacific Gas & Electric Co., lessee of the Sierra & San Francisco Power property, almost two million kilowatt-hours and has delivered to it sixteen million kilowatt-hours.

A bank of auto-transformers was installed at Priest to improve the voltage conditions when the City's transmission line and that of the Pacific Gas & Electric Company are connected. Without these transformers it was difficult to maintain a satisfactory voltage at Priest Portal, as the nominal voltage of the Pacific Gas & Electric Company's line is 17,500 volts, and that of the City's line, 22,000 volts. The transformers have not reduced the capacity of the tie but have greatly improved the voltage conditions along the transmission line adjacent to the Pacific Gas & Electric Company's connection. At times when the City's line is receiving current from the Company, this bank of transformers acts as a booster bank, so that the voltage at which current is received is sufficient to operate the motors at the westerly end of the line.

It is impossible to deliver over the Pacific Gas & Electric Company's line, to which the City's line is connected at Priest Camp, sufficient power to carry on the construction activities on the project at full capacity. When the Early Intake Plant has been out of commission it is necessary to stop nearly all construction operations except at points

which could be supplied with power over the Pacific Gas & Electric Company's lines.

On account of lack of rain during the latter part of 1921, the storage at Lake Eleanor reservoir was depleted to the level of the original lake surface on November 28th of that year. Power developed from water obtained by excavating the channel from below the original level of the lake to the dam, in conjunction with power secured from the Pacific Gas & Electric Company's line, made it possible to operate Priest heading, the Hetch Hetchy Dam work and to maintain the pumps at the Second Garrotte and Big Creek shafts. The delay on the project due to this water shortage was about one month.

From February 25 to March 27, 1922, the Early Intake Power Plant was out of service, due to a slide which took out about 300 feet of the concrete lined canal supplying water to the turbines in the power house. This break was repaired by constructing a temporary wooden flume on the canal bench. Twelve days later, the whole side of the hill upon which the canal was located slipped out, moving some 340,000 cubic yards of material. This slide carried out the new temporary flume, as well as a portion of the canal, leaving a gap over 500 feet in length. The hillside was left in such condition as to prohibit temporary construction until additional material which was likely to slide had been sluiced down to a stable slope. This was done and the break then closed with a redwood stave pipe, six feet in diameter. Operation of the power plant was resumed April 21, 1922. This break is being by-passed by means of a tunnel 1,380 feet long, as the ground on which the pipe is constructed is not a satisfactory foundation for permanent construction.

These power interruptions, all of which were unavoidable, indicated the desirability of establishing an adequate connection with the Pacific Gas & Electric Company's system which will permit continued prosecution of the work in the

event of any future interruption of service from the Early Intake Plant. The estimated cost of increasing the capacity of the Pacific Gas & Electric Company's line at present connected to the City's line at Priest camp was found to be excessive. It was therefore decided to secure an adequate outside connection by building a new line along the aqueduct line from the Moccasin Creek power house site towards San Francisco to Pedro Siding on the Hetch Hetchy Railroad, where the line runs close to the terminus of a second and heavier line of the Pacific Gas & Electric Company. This line from Moccasin Creek to Pedro Siding is 7.1 miles long and the Pacific Gas & Electric Company's connecting line a little more than four miles in length from the Don Pedro power house to Pedro Siding.

The construction of the City's new line is being done by the Hetch Hetchy Water Supply force and is 20 per cent completed. The Pacific Gas & Electric Company is at work on the line from Don Pedro power house to Pedro Siding. This line will be completed and ready for service in time to assist in tiding the Lower Cherry Plant over the low water period between September and December. Power will be received at 60,000 volts at Moccasin Creek and stepped down at this point to 22,000 volts to connect with the Early Intake transmission system.

From July 1, 1920, to June 30, 1922, the power handled by the system was as follows:

Results of Operation of Lower Cherry River Power System.
From July 1, 1920, to June 30, 1922.

	July 1, 1920, to June 30, 1921.	July 1, 1921, to June 30, 1922
Generated at Early Intake Plant	22,428,600 k.w.h.	19,337,000 k.w.h.
Metered in from P. G. & E. Co. at Priest	86,000 k.w.h.	1,798,000 k.w.h.
Total	22,514,600 k.w.h.	21,135,000 k.w.h.
Metered out to P. G. & E. Co. at Priest	11,973,312 k.w.h.	4,021,000 k.w.h
Metered out to Utah Construction Co. at Hetch Hetchy Dam	952,788 k.w.h.	1,219,000 k.w.h.
Used by the City (including Contract 77-C)	4,987,341 k.w.h.	11,979,000 k.w.h.
Miscellaneous small consumers, losses, and unaccounted for	4,601,159 k.w.h.	3,916,000 k.w.h.
Total	22,514,600 k.w.h.	21,135,000 k.w.h.

Aqueduct in the Peninsular and Bay Crossing Divisions.

The water which San Francisco obtains from east of the Bay is now limited to about 21 million gallons daily. A greater supply from the developed sources east of the Bay will be made available by a conduit across Dumbarton Strait and westward to Crystal Springs Reservoir. Work now in progress has for its object the construction of a part of the Hetch Hetchy aqueduct, which will be used for this purpose immediately upon its completion.

Land is being purchased for a right of way 60 to 100 feet wide from Irvington to the east shore of Dumbarton Strait, and from the west shore of the strait through the southern part of Redwood City to Crystal Springs Reservoir.

The aqueduct will be constructed as follows:

Aqueduct from Irvington to Crystal Springs Reservoir.

Character of Conduit.	Location.	Approximate Length.
60″ steel pipe	Irvington to Redwood Portal	19 miles
Submarine pipe	Dumbarton Strait, Navigable channel	2,000 ft.
Submarine pipe	Newark Slough, Navigable channel	250 ft.
10′ 3″ reinforced concrete pipe	At east end of Pulgas Tunnel	450 ft.
10′ 3″ concrete lined tunnel (Pulgas Tunnel)	Redwood Portal to Crystal Springs Portal	1.7 miles
Concrete lined canal (Crystal Springs Outfall)	Crystal Springs Portal to Canada de Raymundo Creek	1,000 ft.

Pulgas Tunnel:

The Pulgas Tunnel, now under construction, is to pierce the ridge immediately east of Crystal Springs Reservoir. It will be about 1.7 miles long, beginning in a branch of Cordilleras Creek Canyon on the Redwood City side, and ending about 1,000 feet from Canada de Raymundo Creek, which flows into Crystal Springs Reservoir. The slope is 0.4 foot per thousand feet. An open concrete lined canal will discharge the water from the tunnel into the creek.

The contract for the Pulgas Tunnel was awarded on June 23, 1922, to Grant Smith & Co. of San Francisco at an estimated price of $683,050. An itemized schedule of the bids submitted is given on page 156.

Bay Crossing Division:

Steel pipe will be used for the aqueduct from Irvington to Redwood Portal. In and near Redwood City and Newark, where the line crosses a close succession of streets, the pipe will be placed underground. On the marshes on both sides of San Francisco Bay and over the shallow part of Dumbarton Strait, the pipe will be supported on a trestle. The navigable channel at Dumbarton Strait and at Newark Slough will be crossed by submarine pipe.

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA.

CONTRACT NO. 85

PULGAS TUNNEL

RECORD OF BIDS RECEIVED

Bids received June 21, 1922

Contract awarded June 23, 1922, to

GRANT SMITH & CO.

	No. 1	No. 2.	No. 3	No. 4	No.	No.
	Bidder's Name and Address	Bidder's Name and Address	Bidder's Name and Address	Bidder's Name and Address	Bidder's Name and Address	Bidder's Name and Address
	Grant Smith & Co. 708 Balboa Bldg. San Francisco	Utah Construction Co. 824 Phelan Bldg. San Francisco	F. Rolandi 550 Montgomery St. San Francisco	Construction Company of North America Mills Bldg. San Francisco		
	Total bid on entire contract	Total bid on entire contract	Total bid on entire contract	Total bid on entire contract	Total bid on entire contract	Total bid on entire contract
	$683,050	$710,582	$744,650	$779,310		

Item No.	ITEM	Quantity Estimated	Unit	No. 1 Unit Price Bid Dollars Cts	No. 1 Total Bid Dollars Cts	No. 2 Unit Price Bid Dollars Cts	No. 2 Total Bid Dollars Cts	No. 3 Unit Price Bid Dollars Cts	No. 3 Total Bid Dollars Cts	No. 4 Unit Price Bid Dollars Cts	No. 4 Total Bid Dollars Cts	No. Unit Price Bid Dollars Cts	No. Total Bid Dollars Cts	No. Unit Price Bid Dollars Cts	No. Total Bid Dollars Cts
1.	Constructing lined tunnel	8 500	lin.ft.	62	527 000	66 75	567 375	75	637 500	69 35	589 475				
2.	Extra price for permanently timbered tunnel	3 500	lin.ft.	18	63 000	13	45 500	6	21 000	20 25	70 875				
3.	Additional excavation in tunnel	500	cu.yd.	5	2 500	3	1 500	4	2 000	7	3 500				
4.	Additional concrete in tunnel	500	cu.yd.	20	10 000	2 66	1 330	13 50	6 750	16	8 000				
5.	Air shaft	1	shaft	1500	1 500	1160	1 160	4000	4 000	1610	1 610				
6.	Earth excavation in open cut	15 000	cu.yd.	75	11 250	60	9 000	1	15 000	2 50	37 500				
7.	Rock excavation in open cut	2 000	cu.yd.	1 75	3 500	1 25	2 500	2 50	5 000	3 50	7 000				
8.	Constructing 10' 3" reinforced concrete pipe	750	lin.ft.	50	37 500	68 50	51 375	42	31 500	48 20	36 150				
9.	Concrete in canal lining	1 000	cu.yd.	20	20 000	23 58	23 580	15	15 000	16	16 000				
10.	Mass concrete in miscellaneous structures	100	cu.yd.	20	2 000	23 58	2 358	20	2 000	28	2 800				
11.	Reinforced concrete in miscellaneous structures	100	cu.yd.	25	2 500	23 58	2 358	22	2 200	30	3 000				
12.	Embankment	500	cu.yd.	1	500	60	300	80	400	2	1 000				
13.	Extra cement	200	barrels	4 50	900	5 23	1 046	4 50	900	4	800				
14.	Reinforcing steel	10 000	pounds	05	500	06	600	06	600	04	400				
15.	Placing metal work furnished by the City	20 000	pounds	02	400	03	600	05	1 000	06	1 200				
1-15	TOTAL, ALL ITEMS				683 050		710 582		744 850		779 310				
	Amount of certified check				70 000		66 508 23		75 000		86 231 50				

Expenditures on Hetch Hetchy Project for Fiscal Years Ended June 30, 1921 and June 30, 1922.

Water Construction.

Acct. No.	Primary Accounts.	—Fiscal Years Ended— June 30, 1921	June 30, 1922
	General Expenditures		
2002	Lands, water rights and rights of way	$26,336.95	$12,227.98
2003	Rentals to U. S. Government	15,000.00	15,000.00
2004	Legal expense	9,935.49	12,115.43
2005	Hydrography	3,729.01	2,837.95
2006	City office administration	32,083.18	35,587.65
2007	City office engineering	42,518.60	41,165.84
2008	State Compensation Insurance Fund	8,618.87	*8,825.35*
2009	Taxes	6,536.15	6,264.88
2010	Miscellaneous construction expenditures	32.50	11,904.41
2012	Unamortized discount on securities and expense	298.88	9,460.93
2101	Groveland office administration and engineering	32,806.28	38,379.25
2102	Groveland hospital building and equipment	2,831.80	2,073.21
2104	Groveland hospital operating expenses	14,548.82	23,882.97
2110	Groveland dwellings	11,221.99	15,974.74
2111	Groveland warehouse	5,613.99	6,771.42
2112	Groveland permanent water supply.	9,790.63	326.93
2124	Groveland general stable and garage equipment	*7,773.53*	*1,253.93*
	Hetch Hetchy Division.		
2202	Engineering	$16,201.22	$31,877.07
2203	Camps	4,273.91	3,826.17
2204	Roads, trails and tramways	894.57	369.71
2205	Dam and appurtenances	2,100.91	1,549.74
2205	Dam construction (Contract 61)	553,747.38	2,042,880.95
2206	Clearing reservoir	624.71	107,491.27
2208A	Dam and appurtenances, slide gates (Contract 66)	60,537.00	65,987.35
2208B	Dam and appurtenances, slide gates (Contract 67)	114,775.20	60,614.47
2208C	Dam and appurtenances, 5-ft. balanced valves (Contract 68)	123,881.10	54,979.03
2208D	Dam and appurtenances, 3-ft balanced valves (Contract 69)	105,873.18	990.00
2211	Sawmill operations	1.08	. . . . .
2226	Telephone and telegraph lines	106.75	272.51
2227	Camp maintenance	929.78	280.90

Italics indicate Credit.

Expenditures on Hetch Hetchy Project.

Water Construction (Cont.)

Acct. No.	Primary Accounts.	—Fiscal Years Ended— June 30, 1921	June 30, 1922
	Tunnel Construction.		
2401	Preliminary investigations and surveys	$ .50	$. . . . .
2402	Engineering	23,644.08	39,820.68
2403	Camps	1,988.57	5,368.76
2404	Roads, trails and tramways	401.62	1,469.37
2405	Adits	15.44	. . . . .
2406	Shafts	20,896.69	1,346.08
2407	Construction, City's forces	41,261.48	1,365.89
2407	Construction, (Contract 77C)	1,992,446.94	2,948,188.69
2408	Early Intake C. & C. Aqueduct	237.40	37.45
2426	Telephone and telegraph lines	801.25	126.02
2427	Camp maintenance	1,691.43	1,391.12
	Early Intake Diversion Works.		
2901	Preliminary investigation and surveys	. . . . .	$ 6,382.91
2902	Engineering	. . . . .	380.78
2904	Roads, trails and tramways	. . . . .	673.78
2905	Dam and appurtenances	. . . . .	18,209.83
	Mather Sawmill.		
3003	Camps	2,366.61	53.81
3004	Roads, trails and tramways	548.94	520.59
3005	Sawmill and equipment	8,628.08	47.06
3006	Stumpage rights and lands	. . . . .	1,204.20
3027	Camp maintenance	546.78	295.30
3070	Operating expenses	69,431.32	103,778.57
	Munn Sand Pit		
3101	Plant and equipment	. . . . .	16,378.29
3170	Operating expenses	. . . . .	3,167.20
3501	Golden Rock Ditch — Operating expenses	1,618.68	1,698.98
	Boarding and Commissary Expenses.		
4000	Boarding houses	150,180.55	181,779.55
4500	Commissary supplies	. . . . .	*9,708.29*
4510	Commissary supplies expenses	. . . . .	*1,747.00*
5000 5010	Material and supplies Misc. Construction expenditures Includes purchases for the current years and distribution to the various units of the Project for three years 1919-1922	*180,001.88*	*96,277.61*

Italics indicate Credit.

Expenditures on Hetch Hetchy Project.

Water Construction (Cont.)

Acct. No.	Primary Accounts.	—Fiscal Years Ended— June 30, 1921	June 30, 1922.
	Bay Development Division.		
6002	Lands, water rights and rights of way	.....	10,530.00
	Redwood Section.		
6301	Preliminary investigations and surveys	.....	4,501.72
	Peninsular Division.		
6401	Preliminary investigations and surveys	.....	1,724.36
		$3,349,327.84	$5,837,721.55
	Credit a/c sales of materials, refunds, etc.	*18,800.71*	(a)
	Total Gross Charges, Water Construction	$3,330,527.13	$5,837,721.55
	Under the terms of the City's Contract (No. 77C) versus the Construction Co. of No. America, the Contractor is charged for all material and power furnished, and for all services rendered by the City. The charges for such services are included as expenditures as herein set forth against the Contract (Acct. No. 2407) and deducted as listed below, as such charges are not covered directly by actual cash expenditures.		
	Difference in Hospital dues collected.	*$ 2,472.06*	*$ 4,330.63*
	Lumber furnished contractor.....	*28,094.86*	*23,451.87*
	Power furnished contractor.....	*51,382.68*	*115,368.54*
	Transportation of employees.....	*7,149.64*	*6,637.30*
	Transportation of material and supplies	*13,780.70*	*17,040.81*
	Total credit	*1,028,79.94*	*166,829.15*
	Net expenditures Water Construction	$3,227,647.19	$5,670,892.40

Miscellaneous Receipts, Refunds, etc.

During the fiscal year, 1921-1922, the following receipts accrued from sales of material, miscellaneous cash collections, refunds, rebates from the State Compensation Insurance Fund. These amounts have been deposited with the City Treasurer to the general Hetch Hetchy Bond Fund and **credited back herein** to the various appropriate sub accounts.

(a) See Miscellaneous Receipts, Refunds, etc. Exhibit.
Italics indicate Credit.

Expenditures on Hetch Hetchy Project.
Water Construction (Cont.)

Acct. No.	Primary Accounts.	—Fiscal Years Ended— June 30, 1921	June 30, 1922.
	Material, supplies, etc.	.....	16,952.94
	State Compensation Insurance Fund..	.....	67,284,21
	Total Miscellaneous Receipts.	.....	$84,237.15
	Receipts from operations not included in the foregoing, deposited to the General Hetch Hetchy Bond Fund.		
2002	Crocker Amazon Tract, Sale of buildings and material.....	$ 1,675.00	$ 3,395.00
2002	Crocker Amazon Tract, Rentals	2,300.00	2,262.90
2002	Yosemite Park Co., Rentals....	50.00	50.00
2103	Groveland Hospital, Receipts..	12,365.51	19,753.02
2109	Groveland Dwellings, Rentals..	2,280.00	2,205.00
2112	Groveland Water Supply, Receipts	253.65	993.13
3040	Mather Sawmill, Receipts.....	10,000.39	647.77
3500	Golden Rock Ditch, Receipts..	264.60	
4000	Boarding houses and commissarial outfits, City's forces...	79,937.73	161,434.08
4000	Boarding houses and commissarial outfits, Contractor's forces	144,228.33	249,125.52
	Total receipts from operations	$253,355.21	$439,866.42
	Power Construction.		
	Lake Eleanor Division		
2301	Preliminary investigations and surveys	$ 11.90	.....
2302	Engineering	10.92	10.15
2303	Camps	140.17	1,555.23
2304	Roads, trails and tramways....	2,320.79	1,680.98
2305	Dam and appurtenances	64.02	8,577.69
2306	Clearing reservoir	8,626 30	23,137.98
2326	Telephone and telegraph lines..	69.67	116.47
2327	Camp Maintenance	545.32	92.75
	Priest Division		
2501	Preliminary investigations and surveys	.....	11.01
2502	Engineering	731.36	8,704.25
2503	Camps	.....	31,955.20
2504	Roads, trails and tramways....	167.75	8,423.22
2505	Dam and appurtenances.....	15.50	293,203.83
2506	Clearing reservoir	1,747.24	843.70
2507	Outlet Tunnel	.....	29,524.13
2508	Diversion Tunnel, sub-contract..	.....	54,344.26
2526	Telephone and telegraph lines..	.....	67.59
2527	Camp Maintenance	.....	787.77

Italics indicate Credit.

Expenditures on Hetch Hetchy Project
Power Construction (Cont.)

Acct. No.	Primary Accounts.	—Fiscal Years Ended— June 30, 1921	June 30, 1922
	Moccasin Creek Division		
2601	Preliminary investigations and surveys	1,880.38	8.58
2602	Engineering	.....	1,917.34
2603	Camps	.....	30,290.30
2604	Roads, trails and tramways	.....	5,891.11
2605	Lands devoted to electrical purposes	14,265.73	32.74
2606	Penstock	7.75	1,377.79
2607	Power plant building and structures	19.81	1,113.84
2626	Telephone and telegraph lines	.....	744.79
2627	Camp Maintenance	.....	131.10
	Lower Cherry Power Development		
2802	Engineering	186.35	485.13
2803	Camps	278.23	366.62
2804	Roads, trails and tramways	706.21	200.18
2806	Penstock	290.70	
2807	Power plant, buildings and structures	252.28	.....
2808	Hydraulic power plant equipment	27.59	.....
2813	Power plant miscellaneous equipment	144.04	.....
2814	Transmission line, poles and fixtures	3,058.79	5,603.58
2815	Transmission line overhead construction	502.91	3,028.35
2816	Transmission line clearing	70.87	1,883.97
2817	Transmission line, sub-station buildings and equipment	43.82	205.42
2818	Transmission line, sub-station equipment	3,585.19	6,344.44
2819	Transmission line, miscellaneous equipment	.....	50.06
2820	Transmission line, transformers and devices	10,604.10	16,308.90
2822	Transmission line, meters	1.31	.....
2826	Telephone and telegraph lines	38.20	.....
2827	Camp maintenance	55.69	.....
2870	Operating expenses	32,414.01	138,710.70
	Total expenditures, Power Construction	$ 82,884.90	$677,730.45
	Credit account of sales of material, refunds, etc	*559.62*	.....
	Net expenditures, Power Construction	$ 82,325.28	$677,730.45
	Receipts—Power Construction.		
2840	Sales of Power—Receipts	$ 72,234.59	$ 23,782.92

Italics indicate Credit.

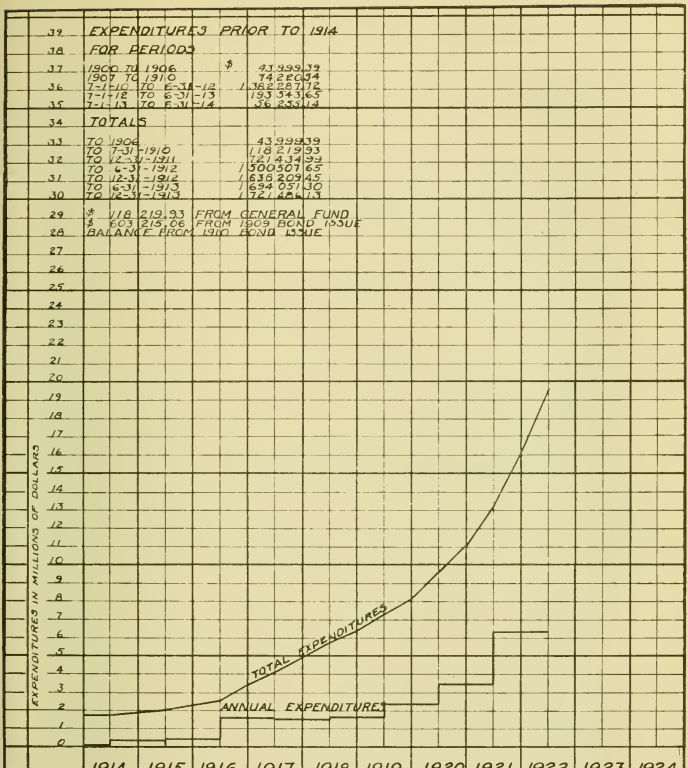
Expenditures on Hetch Hetchy Project.

	—Fiscal Years Ended— June 30, 1921	June 30, 1922.
Hetch Hetchy Railroad		
Investment Account, Additions and Betterments	$288,013.84	$115,614.24
Investment Account, Material and Supplies	1,477.58	22,058.57
Total Investment Account	$289,491.42	$137,672.81
Operating expenses	290,704.33	479,487.94
Total Railroad Expenditures.	$580,195.75	$617,160.75
Receipts from Railroad Operations.		
Freight revenue	$ 69,008.07	$161,859.99
Passenger revenue	20,344.31	31,312.02
Mail revenue	.....	2,960.95
Miscellaneous revenue	1,319.66	604.30
Total Receipts	$ 90,672.04	$196,737.26
Note:—In addition to the foregoing, the Railroad performed non-revenue service for Water and Power construction based on tariff rates and fares as follows:		
Freight and passenger service	$ 32,221.23	$ 89,433.79
Transportation for Investment	13,415.63	6,528.91
Total non-revenue service	$ 45,636.86	$ 95,962.70
These amounts were included in reports to the California Railroad Commission for years ended December 31, 1920 and December 31, 1921.		

Summary of Expenditures and Receipts

Expenditures		
Water Construction	$3,227,647.19	$5,670,892.40
Power Construction	82,325.28	677,730.45
Railroad Construction and Operation.	580,195.75	617,160.75
Total Expenditures	$3,890,168.22	$6,965,783.60
Receipts		
Water Construction	$ 253,355.21	$ 439,866.42
Power Construction	72,234.59	23,782.92
Railroad Operations	90,672.04	196,737.26
Total Receipts	$ 416,261.84	$ 660,386.60
Net expenditures for fiscal year	$3,473,906.38	$ 6,305,397.00
Net expenditures prior to beginning of fiscal year	9,727,618.16	13,201,524.54
Total expenditures to end of fiscal year	$13,201,524.54	$19,506,921.54

Italics indicate Credit.



HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

GRAPHIC RECORDS OF

ANNUAL AND TOTAL EXPENDITURES

DEPARTMENT OF PUBLIC WORKS. APPROVED M. M. O'Shaughnessy ..... CITY ENGINEER

BY H.O.S. . . . TRACED H.O.S. . . CHECKED . . . .

SCALE . . . . . DATE MARCH . 8, 1922

A 166

CONTENTS.

	Page
INTRODUCTION	5
BOULEVARDS, STREETS AND HIGHWAYS	7
SEWERS	33
MISCELLANEOUS CONSTRUCTION:—	
Aquatic Park	36
Esplanade	36
Columbia Heights Fire Cistern	39
Street Signs	39
Public Comfort Station	41
Board Walk Along Great Highway	41
Relief Home Tank	42
Proposed Work	42
PROJECTS AND INVESTIGATIONS:—	
Rincon Hill	43
Golden Gate Heights	43
Ingleside Heights	47
Sunset Tunnel	48
San Francisco Bay Bridges	53
Van Ness Avenue Extension	53
Islais Creek District Industrial Sites	54
Miscellaneous Studies and Investigations	54
SURVEYS	55
STREET IMPROVEMENT ASSESSMENTS, ETC	57
MUNICIPAL RAILWAYS:—	
Market Street Railway Purchase	59
Extensions	66
Congestion on Market Street	69
Equipment	71
Contracts	72
HETCH HETCHY WATER SUPPLY	73
Organization	74
Groveland Headquarters	77
Road and Bridge Work	84
Hetch Hetchy Dam	85
Lake Eleanor Dam and Reservoir	108
Aqueduct in the Sierra Nevada	110
Early Intake Diversion Works	132
Moccasin Creek Power Development	133
Hetch Hetchy Railroad	138
Munn Sand Plant	147
Mather Sawmill	147
Lower Cherry River Power Development	150
Aqueduct in the Peninsular and Bay Crossing Division	154

ILLUSTRATIONS AND DIAGRAMS.

Page

POINT LOBOS AVENUE AND CLIFF HOUSE ..... Frontispiece

SAN FRANCISCO BAY REGION:—Showing Proposed Dumbarton Bridge and Peninsular Highways 8

CONCRETE PAVEMENT:—Forty-fifth Avenue Between Anza and Balboa Streets 10

POINT LOBOS AVENUE, FORTY-EIGHTH AVENUE TO GREAT HIGHWAY (CLIFF HOUSE ROAD):—
- Cliff House Road in 1881 12
- Point Lobos Avenue in 1922 13
- Upper Section Around Sutro Heights 15
- Viaduct at Ocean's Edge 16

MARKET STREET EXTENSION:—
- View of Paving of Easterly Section 18
- View of Upper Section After Grading 20

LAGUNA HONDA BOULEVARD:—Southerly Section at the Relief Home 22

SPECIAL TREATMENT IMPROVEMENT ON QUESADA AVENUE 27

ARMY STREET, DE HARO STREET TO THIRD STREET:—
- Before Improvement 30
- After Improvement 31

OCEAN BEACH ESPLANADE:—
- Different Stages of Construction 37
- General View of Esplanade and Great Highway 38

STREET SIGN 40

GOLDEN GATE HEIGHTS:—
- View of District 44
- Proposed Street Plan 46

SUNSET TUNNEL (DUBOCE AVE. ROUTE):—Plan, Profile and Cross-section ..... Opposite 48

DISTRICT AROUND WESTERLY PORTAL OF TWIN PEAKS TUNNEL:—
- View in 1917, Before Car Service Was Established 50
- View in 1921, Showing Home Building as a Result of Rapid Transportation 51

CENTER ENTRANCE CAR, MUNICIPAL RAILWAY 70

NUMBER OF MEN EMPLOYED AND COSTS OF LABOR AND MATERIAL, H. H. W. S. (Graphic Record) 76

ILLUSTRATIONS AND DIAGRAMS.—Cont'd.

Page

HETCH HETCHY DAM:—
General View of Damsite with Excavation Practically Completed 91
View of South Abutment 92
Pouring Concrete in Base of Dam 94
View of Downstream Face and Top of Concrete—Illuminated for Night Work 95
Progress Chart of Concrete Placing ..... Opposite 96
General View of Dam and Portion of Reservoir 97
Drainage and Inspection Wells 99
Slide Gates in Place 100

HETCH HETCHY AQUEDUCT TUNNEL:—
Progress Profile Chart ..... Opposite 112
Diagram of Tunnel Progress 113
Camp at South Fork Tunnel Portal 115
Camp at Adit 5-6 118
At Big Creek Shaft 121
Tunnel Face at Adit 8-9, Showing Arrangements for Drilling and Mucking Machine 127

PRIEST DAM, MOCCASIN CREEK POWER DEVELOPMENT, H. H. W. S.:—
General View of Dam and Reservoir During Construction 134
View of Upstream Toe, Showing Rip-rap Paving 136

MATHER SAWMILL, HETCH HETCHY WATER SUPPLY PROJECT 148

ANNUAL AND TOTAL EXPENDITURES, H. H. W. S. (Graphic Record) 163

TABLES.

Page

STREET WORK PERFORMED UNDER CONTRACT—Quantities and Cost....Opposite 32

SURVEYS PERFORMED.... 55

PRECISE LEVELS AND BENCH MARKS.... 55

MAPS APPROVED AND FILED.... 55

FEES RECEIVED FOR SURVEYS.... 56

FEES RECEIVED FOR INSPECTION.... 56

ASSESSMENTS AND BONDS FOR STREET WORK.... 57

STREET WORK PROCEEDINGS.... 57

NOTICES, PERMITS AND INVESTIGATIONS.... 57

PERMITS AND FEES FOR CORPORATION TRENCHES, ETC. 58

STATEMENT OF MARKET STREET RAILWAY VALUATION 66

CURRENT CONTRACT DATA—Boulevards, Sewers, Municipal Railways, etc....Opposite 72

ITEMIZED RECORD OF CONSTRUCTION PROGRESS—Hetch Hetchy Dam (Contract 61), H. H. W. S.... 88

PROGRESS OF EXCAVATION—Mountain Division Tunnels, Hetch Hetchy Aqueduct (Contract 77-C), H. H. W. S.... 112

MECHANICAL EQUIPMENT INSTALLED FOR AQUEDUCT CONSTRUCTION, H. H. W. S.... 125

ROLLING STOCK—Hetch Hetchy Railroad.... 143

TIME TABLE—Hetch Hetchy Railroad.... 146

OUTPUT OF MATHER SAWMILL.... 149

CAPACITIES OF SUBSTATIONS—Lower Cherry River Power System, H. H. W. S.... 150

RESULTS OF OPERATION—Lower Cherry River Power System, H. H. W. S.... 154

AQUEDUCT FROM IRVINGTON TO CRYSTAL SPRINGS RESERVOIR, H. H. W. S.... 155

RECORD OF BIDS RECEIVED—Pulgas Tunnel (Contract 85), H. H. W. S.... 156

EXPENDITURES ON HETCH HETCHY WATER SUPPLY PROJECT—For fiscal years ended June 30, 1921, and June 30, 1922.... 157

CONTRACT DATA—Hetch Hetchy Water Supply Project....Appendix

TE. OF EPTANCE	FINAL ESTIMATE: CONTRACT ITEMS	FINAL ESTIMATE: EXTRAS AND DEDUCTIONS	FINAL ESTIMATE: AMOUNT PAID	ELAPSED TIME FROM SIGNING TO ACCEPTANCE DAYS	REMARKS	CONTRACT NO
21. 17	Col 18	Col. 19.	Col. 20	Col 21	Col. 22	Col 23
	$2,321,169.46	$ + 77,666.04 - 9,649.97	$2,389,185.53			
	$	$	$		Bid rejected as excessive Contract let as per City Schedule	39
4.1919	17,775.00	(a) 21.75	17,753.00	119	Two bids were received, as follows: Joshua Hendy Iron Works, either 45.00 or 75 steel cars at $395 each. Raisch Construction Co 50 to 60 second-hand rebuilt wood body cars at $200 each. The latter cars were bid as alternate to the steel cars & are not fitted with roller bearings	40
3.1918	1,733.49		1,733.49	71	Railings at sides of roadway across dam	41
19.1918	2,421.00		2,421.00	61	Three lowest bids were not in accordance with specifications	42
38.1919	5,600.00		5,600.00	152	Sept. to Dec. inclusive. 1918.	43
						44
	5,224.75		5,224.75	101 *	*Contract closed by expiration Dec. 31, 1918.	45
18.1919	1,676.25	386.25	1,290.00	145	Freight @ 386.25 cut out and billed separately Contract modified to save time. Original bid $1,676.50 Extension of 30 days from Nov 1 acct. of war conditions.	46
					Bids rejected as excessive All bids identical in amount	47
5.1919	4,740.00	402.30	5,142.30	147	Extra acct. shipment of individual blowers @ $30 each, also extra work authorized by Board of Works @ $24.10 each	48
5.1919	1,702.44		1,702.44	130		49
2.1919	1,612.48		1,612.48	10		50
11.1919	5,390.00	+ 1,355.00 - 18.49	6,726.51	61	Extra $1,355. for metal work on car shop, authorized by Bd of Wks $18.49 deducted for work performed by city.	51
30.1919	4,492.20		4,492.20	85	Extension of 30 days from Mar 2.18 acct. of an accident at the sheet mills of the Inland Steel Co.	52
30.1919	8,000.00		8,000.00	167	Jan. to June inclusive. 1919.	53
					Bids rejected as excessive. Beef purchased in open market	54
14.1919.	2,587.00		2,587.00	45		55
					Included later in Contract 59.	56
18.1919.	6,428.03	2,975.35	9,403.38	86	Extra $ 2,975.35 for 1505 ft of pipe & 91 clinch bands, authorized by Bd of Wks.	57
1.1919.	2,373.00		2,373.00	23	Surplus material bought by city. 529 lbs. @ $ 7.75 per 100 lbs.	58
					Bids rejected as excessive Work performed by city	59
15.1919.	3,031.50	2.27	3,033.77	15	Extra $ 2.27 to cover additional 3'-9" of pipe furnished under this contract	60
	$2,395,956.60	$2,400.96 - 10,076.71	$2,468,280.85			

CONTRACTS – HETCH HETCHY WATER SUPPLY

No.	Item No.	Div.	General Description	Location of Work or Item for which Water, Etc. was Purchased	Engineer's Estimate of Cost	Amount of Bond for Performance	Date of Opening Bids	No. of Bids	Highest Bid	Lowest Bid	Successful Bid	Contractor	Contractor's Address	Date of Award	Date of Signing Contract	Time Allowed in Days	Date of Acceptance	Final Estimate: Contract Price	Final Estimate: Extra and Any Deductions	Final Estimate: Amount Paid	Remarks
	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10	Col. 11	Col. 12	Col. 13	Col. 13A	Col. 14	Col. 15	Col. 16	Col. 17	Col. 18	Col. 19	Col. 20	Col. 21
	TOTALS BROUGHT FORWARD FROM SHEET 3				$ 2,335,950.00	$ 426,850			$ 1,746,474.00	$ 1,178,641.50											
39	Furnishing & delivering Fresh Beef from August to November inclusive 1918	Gen	42,000 lbs. of fresh beef f.o.b. Groveland & Domi.te	Boarding Houses	$ 7000.00	$ 1500	Aug 6 '18	5	$ 8633.00	$ 960.00		No award									
40	Furnishing & delivering Dump Cars Main Aqueduct Mountain Division	Mtn	45 - 3 cubic yard side dump cars steel body, f.o.b. H H. Junc	Aqueduct tunnels Mountain Division	18000	5000	Sept. 8 '18	2	19,750.00	18000.00	17,735.00	Joshua Hendy Iron & Steel Co	San Francisco	Sept. 18 '18	Oct. 8 '18	(p)	Feb. 4 '19	17,735.00	(a)	17,735.00	9 bids were received and opened at the office of the Board of Public Works at 9 A.M. Sept. 8 '18. The specifications required that the cars should be of 3 cubic yard capacity each. Each proposal was required to name a second and third price for cars of 2 and 4 cubic yards capacity respectively. The other bidders did not comply with the specifications and are not named in the above tabulation.
41	Furnishing & delivering Standard Wrought Iron Pipe Galvanized	L E	Approx. 2" Std. W.I. Pipe 96% T 60 " " " 3% 30 " " " 4%	Lake Eleanor Dam	1500	350	Aug 6 1918	7	2,094.48	993.60	1,534.80	Holbrook, Merrill & Stetson	64 & 66 Natoma St. San Francisco	Aug. 19 '18	Sept. 19 '18	To Sept. 1 1918	Dec. 5 1918	1,535.49		1,535.49	71 Railroad sidings at Lake Eleanor reservoir site. Access to dam
42	Furnishing & delivering Standard Wrought Iron Pipe, Black Pipe Fittings & Valves	Mtn	5000 ft. 2" Std. W.I. Pipe, Blk 200 " " " Galv. " 100 " 2" C.I. Screw and 90° Elbows 50 " " " 45° " 200 " 2" " Tees 100 " 2" Heavy Std. brass Gate Valves	Aqueduct tunnels Mountain Division	1,000	500	Aug 16 1918	6	2,470.35	2,851.20	2,421.00	Crane Co.	2nd & Brannan St. San Francisco	Aug. 19 '18	Aug. 29 '18	To Sept. 1 1918	Oct. 28 1918	2,421.00		2,421.00	6 Free delivery to nearest railroad station in accordance with specifications
43	Furnishing & delivering Locomotive Fuel Oil	R R	3500 bbls. fuel oil, f.o.b. cars at contractors plant	Hetch Hetchy Railroad	5000	1,750	Aug 1 1918	1	5,600.00	5,600.10	5,600.00	Union Oil Co.	Mills Bldg. San Francisco	Aug. 13 1918	Aug. 19 1918	Commence Dec. 1 1918	Jan. 18 1919	5,600.00	192	5,408.16	Contract to Dec. 31 1918
44	Boring of Test Holes across Bay Channel at Dumbarton Straits	B C	6 Test holes distributed from 100 ft. to 300 ft. apart, bored to a depth as required by the City Eng.	Bay Crossing division of aqueduct bet. Dumbarton & Ravenswood					Bids not yet called for												
45	Furnishing & delivering Fresh Beef from September 1st to December inclusive 1918	Gen	40,000 lbs. of fresh beef f.o.b. Groveland & Damsite	Boarding Houses	6000	1500	Sept. 4 '18	3	9036	[illegible]	[illegible]	S. A. Ferretti	Merced [illegible]	Sept. 6 1918	Sept. 7 '18	101		5,274.15		5,274.15	101 Contract closed by expiration Dec. 31
46	Furnishing & delivering Frogs & Switch Fittings for Light Rail	Mtn	30 - Riveted Pl. Frogs Rail Sec. 30# 30 - Sets Stub Switch Fittings 14 oz. 30 - Parallel Ground Throw Switch Stands. Note: 30 Turnouts complete incl. ground throw substituted for 30 Stub Switch Fittings f.o.b. H.H. Junc.	Aqueduct tunnels Mountain Division	700	500	Sept. 4 1918	4	[illegible]	6"6"	6"62	Mann Iron & Machine Co.		Sept. 11 1918 Sept. 16 1918	Sept. 6 1918	90 Days	Feb. 18 1919	1,416.11	584.25	1,249.00	145 Freight rate [illegible] cut and prepaid contract reading to save time of equal half 50% Extra account of narrow [illegible]
47	Furnishing & delivering Cement	L E	10,000 barrels, estimated quantity, f.o.b. H H Junction	Eleanor Dam	31,800	8000	Aug 30 1918	3	6,500.00	6,500.00		No award									Bids rejected as excessive and individually identical
48	Furnishing & delivering Blowers Main Aqueduct Mountain Division	Mtn	3 Positive Pressure Rotary Blowers of the Roots type Capacity 5,000 cu. ft. free air per minute, f.o.b. H. H. Junction	Aqueduct tunnels Mountain Division	5,100	1000	Oct. 16 1918	1	5,244.00	4,740.00	4,740.00	[illegible]	[illegible]	[illegible]	Nov. 18 1918	120	May 5 1919	4,740.00	402.50	4,141.00	141 Failure to set blowers on [illegible] Installation of blowers and motors at Warehouse No. 1
49	Furnishing & delivering Electric Motors for Blowers Main Aqueduct Mountain Div.	Mtn	3 - 75 H.P. 3 phase 60 cycle 440 volt squirrel cage induction motors, f.o.b. H. H. Junction	Aqueduct tunnels Mountain Division	1600	800	Nov. 6 1918	1	1,800.00	1,440.00	1,440.00	Westinghouse Electric & Mfg. Co.	New York City	Nov. 8 1918	Dec. 16 1918	To Mar. 15 1919	May 6 1919	1,181.44		1,181.44	150
50	Furnishing & delivering Standard Wrought Iron Pipe & Couplings Black	Mtn	4,000 ft. of 3" Std. W.I. pipe, blk in random lengths with couplings, f.o.b. H. H. Junction	Aqueduct tunnels Mountain Division	1450	400	Nov. 20 1918	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Dec. 17 1918	15 days after contract	Jan. 1 1919	1,241.48		1,241.48	10
51	Furnishing & erecting Sheet Metal Work for the Groveland Shops	Gen	No. 14 gauge corrugated galv. iron, f.o.b. H. H. Junction	Groveland, Calif.	4500	2,000	Nov. [illegible] 1918	5	[illegible]	5,500.00	4,539.00	Forderer Cornice Works	Potrero Ave. & 6th	Dec. 7 1918 Dec. 18 1918	Dec. 17 1918	To Feb. 4 1919	Feb. 11 1919	4,539.00	(-) 1,359.00 Net 3,180	4,691	61 Extra 1,359 for metal roof shop authorized. Paid 3,180 deducted for work performed by city
52	Furnishing & delivering Air Pipe	Mtn	1,000 ft. of 14" dia. riveted pipe made of No. 16 gauge steel & 700 cinch bands for joints, f.o.b. H. H. Junction	Aqueduct tunnels Mountain Division.	3000	1250	Dec. 27 1918	2	9941.00	4400.00	4,400.00	Vanleeuwen Pipe & Tank Co.	4th & Kentucky St. San Francisco	Dec. 30 1918	Jan. 4 1919	To Apr. 1 1919	Mar. 30 1919	4,497.10		4,497.10	88 Extension of 50 days to complete contract on account of accident to the sheet metal roof of the Hetch Hetchy Shops
53	Furnishing & delivering Locomotive Fuel Oil	R R	9000 bbls. fuel oil, f.o.b. cars at contractors plant	Hetch Hetchy Railroad	9000	1,500	Dec. 27 1918	1	9,000.00	8,400.00	8,000.00	Union Oil Co.	Mills Bldg. San Francisco	Dec. 31 1918	Jan. 16 1919	Jan. 1 to June 30 1919	June 30 1919	8,000.00		8,000.00	181 Jan. 1 to June 30 inclusive
54	Furnishing & delivering Fresh Beef, Jan. to June incl. 1919	Gen	60,000 lbs. of fresh beef f.o.b. Groveland & Damsite.	Boarding Houses	9000	2,000	Dec. 27 1918	2	11,000.00	11,000.00		No award									Bids rejected as excessive. Beef purchased on open market
55	Furnishing & delivering Drill Steel	Mtn	4 Tons, 1" round hollow drill steel 2 " hex "	Aqueduct Tunnels Mountain Division	5,000	500	Jan. 15 1919	2	2,410.00	2,387.80	2,387.80	Ames Iron Works	Oswego, N.Y.	Jan. 16 1919	30 days after opening bids		Mar. 4 1919	2,387.80		2,387.80	45
56	Constructing Standard Camp Bunk Houses	Mtn	6 Std. Camp Bunk Houses Contract for labor only to furnish materials	Permanent camps Mountain Division.	450	700	Feb. 14 1919		No bids received												Included later in contract 53
57	Furnishing & delivering Air Pipe	Mtn	3000 ft. of 24" dia. riveted pipe made of No. 16 gauge steel & 1200 cinch bands, f.o.b. H. H. Junction	Aqueduct tunnels Mountain Division	6800	1000	Mar. 5 1919	4	7,775.00	6,615.00	6,615.00	Dunkirk Pipe & Steel Co.	Kentucky St. Dunkirk, N.Y.	Mar. 10 1919	Mar. 14 1919	90 days after opening contract	June 4 1919	6,615.00	1,915.35	6,615.00	86 Extra 1,915.35 for steel plates and 1,200 cinch bands delivered at H.H. Junction
58	Furnishing & erecting Sheet Metal Work for the Groveland Store Houses	Gen	No. 24 gauge corrugated galv. iron, f.o.b. H. H. Junction	Groveland, Calif.	3,000	500	Mar. [illegible] 1919	5	3,542.00	3,373.00	3,373.00	Percy Sheet Metal Works	345 Guerrero St. San Francisco	Mar. [illegible] 1919	Mar. [illegible] 1919	15 days after opening contract	May 1 1919	3,373.00		3,373.00	29 Applies to Items 58 & 59 Paid for 3,373 lbs. @ $1.15 per cwt.
59	Constructing Depot and Standard Camp Bunk Houses	R R Mtn	Contract for labor only to furnish material	Depot at H.H. Junc. & Permanent camps Mountain Division	2400	500	Mar. 17 1919	4	4,135.00	3,590.00	3,590.00	No award									Bids rejected as excessive. Work performed by City
60	Furnishing & Delivering Standard Wrought Iron Pipe N.R. with Couplings & Protectors	Mtn	5000 ft. of 4" dia. Std. W.I. pipe, blk in random lengths, f.o.b. H.H. Junction	Aqueduct tunnels Mountain Division	3500	800	Mar. 18 1919	8	5,111.00	5,111.00	5,111.00	Geo. W. Tracy Co.	139 Mission St. San Francisco	Mar. 28 1919	Apr. 11 1919	10	Apr. 25 1919	3,031.51	88	3,031.51	15 Extra 88 for screw and coupling for 3,031 lbs. furnished under item 60
	TOTALS CARRIED FORWARD TO SHEET 4				$ 2,404,900.00	$ 435,150.00			$ 2,078,551.42	$ 1,746,474.40	$ 1,196,017.50							$ 1,355,556.60	$ 1,490,382.20	$ 1,355,556.60	
					Does not include contracts not awarded.				Does not include contracts not awarded.												

EXPLANATION OF ABBREVIATIONS IN COL. 3

R R Hetch Hetchy Railroad.
L E Lake Eleanor reservoir and dam.
B C Bay Crossing division.
Mtn Mountain division.
Gen General, applying to two or more divisions or to the project as a whole.

(p) Contract 40 Bidders to state the earliest delivery on first carload & for each carload thereafter. Time of delivery to be an important factor in deciding the award.

(a) Contract 40 Freight charges paid by the city on arrival at one of the shipments.

D. OF CEPTANCE	FINAL ESTIMATE. CONTRACT ITEMS	EXTRAS & DEDUCTIONS	AMOUNT PAID	ELAPSED TIME BETWEEN BEGINNING TO ACCEPTANCE DAYS	REMARKS	CONTRACT NO.
C 17.	Col. 18.	Col. 19.	Col. 20.	Col. 21.	Col. 22.	Col. 23.
	$2 395,959.60	$ + 82,400.00 - 10,071.71	$2,468,280.65			
	2,734,619.90		2,734,619.90		Figures in Cols. 10, 11, 12, are for dam with siphon spillway, contractor furnishing all materials. Figures for overflow spillways were lower.	61
Ju 1, 1919.	5,224.20	-236.80	4,987.40	35	Minus $236.80 acct. lugs substituted for cinch bands.	62
Oc 9, 1918.	5,775.00		5,775.00	107	18 days extension.	63
Se 5, 1919.	2,929.00	- 22.75	2,906.25	49	30 days extension granted acct. changes in deliveries made by City Eng. $22.75 deducted for labor performed by City.	64
Ma 9, 1920.	2,287.50		2,287.50	218	80 days extension granted acct. labor trouble.	65
Fe 24, 1922	121,000.00	3,724.35	124,724.35	747	Extra $3,724.35 to cover Bonus, Test Pcs. & Freight. $1000 paid to R. Hunt for inspection.	66
Ja 0, 1922.	170,000.00	4,929.82	174,929.82	225	Bids of Mar. 24 & Apr. 21 rejected acct. excessive price. Extra to cover Bonus, Test Pcs. & Frght.	67
No 2, 1921	173,100.00	4,080.13	177,180.13	555	Extra $4,080.13 to cover Freight. $1680. paid to R. Hunt for inspection.	68
Ap 7, 1921	98,500.00	7,373.18	105,873.18	378	Extra $7,373.18 to cover Freight & Bonus	69
						70
M 9, 1920.	1,702.00		1,702.00	235	Lowest Bid rejected acct. error in estimate. 140 days extension acct. labor trouble.	71
N 1, 1919.	8,102.10		8,102.10	88		72
Se 11, 1919.	6,678.50		6,678.50	27	12 days extension acct. labor trouble.	73
M 6, 1920.	4,496.63		4,496.63	198	185 days extension acct. labor troubls.	74
De 1, 1919	3,426.13	- 527.04	2,899.09	63	Contract called for 4 miles. About 1 miles completed Contractor released from further work. $527.04 deducted for unfinished surfacing & freight charges due City.	75
Ja 25, 1922	12,431.10	12,353.40	24,784.50	353	Extra $12,431.10 for 4970 ft. of pipe & 300 cinch bands, authorized by Bd. of Wks.	76
	4887 303.34		4887 303.34		* Guaranteed maximum cost.	77 C
						78
						79 A
						79 B
						80
	$10633 535.00 Includes	$ +114,861.24 - 10,363.30 payments uncompleted	$10737530.54 on contracts			

CONTRACTS — HETCH HETCHY WATER SUPPLY

CONTRACT NO	TITLE OF CONTRACT	DIVISION TO WHICH CONTRACT RELATES	GENERAL DESCRIPTION	LOCATION OF WORK, OR LOCATION FOR WHICH MATERIAL ETC. WAS PURCHASED	ENGINEERS ESTIMATE OF COST	AMOUNT OF BOND FOR FAITHFUL PERFORMANCE	DATE OF OPEN BIDS	NO. OF BIDS	HIGHEST BID	LOWEST BID	SUCCESSFUL BID	CONTRACTOR	CONTRACTOR'S ADDRESS	DATE OF AWARD	DATE OF SIGNING CONTRACT	TIME ALLOWED IN DAYS	DATE OF ACCEPTANCE	FINAL ESTIMATE: CONTRACT ITEMS	FINAL ESTIMATE: EXTRAS & DEDUCTIONS	FINAL ESTIMATE: AMOUNT PAID	% OF ENGINEERS ESTIMATE	REMARKS	CONTRACT NO
Col 1	Col 2.	Col 3	Col 4	Col 5.	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12	Col 13	Col 13A	Col 14	Col 15	Col 16	Col 17	Col 18	Col 19	Col 20	Col 21	Col 22	Col 23
TOTALS BROUGHT FORWARD FROM SHEET 3					$ 1404870.00	$ 415750.00			$ 8818331.45	$ 8218174.48	$ 8198013.95							$ 8331,984.45	$ 114,041.00	$ 8446,025.45			
51	Construction of the Hetch Hetchy Dam & Appurtenant Works	H H	Dam to be of concrete masonry with a maximum height above foundations of 430 ft. constructed with a view to future enlargement.	H H Reservoir	$ 4000000.00	$ 400000.00	July 30 1913	1	$ 9415.9.00	$ 9447.791.50	$ 9447.791.50	Hoh Construction Co	814 Phelan Bldg S F	Aug 1 1913	Aug 15, 1913	900		2,794,619.90		$ 14,619.90			51
52	Furnishing & delivering Air Pipe	Mtn	23900 ft of 18" dia riveted pipe made of #8 gage steel & fittings	Aqueduct Tunnels - Mtn Div	5300	800	June 6 1913	2	51.8240	51.24[illegible]	51.24[illegible]	Western Pipe & Steel Co	444 Market St S F	June 30 1913	June 16	75	July 31 1913	2,724.0	-13.80	4.9.140	95	Contract called for 18" dia pipe but substituted 16" for each bends	52
53	Furnishing & delivering Refrigerating Machinery & Equipment	Mtn.	3- Refrigerating & Cooling Plants	Boarding Houses of permanent camps	6000	1,500	June 30, 1913	3	10,36830	5775.00	5775.00	Walter S Leland	57 Second St S.F.	June 3 1913	July 8 1913	60	Oct 28, 1913	5,775.00		5,775.00	107	18 days extension	53
54	Furnishing & delivering Rail Dumping Skips & Side Plates	Mtn	4- Self-dumping skips for vertical shafts	Big Creek Shaft and Second Garrette Shafts	4250	1000	July 2, 1913	2	5320.00	2.93.00	2.93.00	Michael & Pfeffer Iron Works	415 [illegible] San St S.F.	July 9 1913	July 15 1913	45	Sept. 3, 1913	1.93.00	- 9.10	2.93.90	69	[illegible]	54
55	Furnishing & delivering Station Pump for Big Creek Shaft	Mtn	1- Motor Driven Centrifugal Turbine Pump 250 gals per min	Big Creek Shaft	3600	900	July 25 1913	4	3670.00	2.28.50	2.28.50	Worthington Pump & Mch Co	Huron Bldg S.F.	July 30 1913	Aug 14 1913	100	Mar 9, 1914	2.28.50		2.28.50	78	30 days extension granted acct labor trouble.	55
56	Furnishing & delivering 42"x 30" Slide Gates for Hetch Hetchy Dam.	H H	6- 51 sq Gates complete with all operating mechanism.	Hetch Hetchy Dam	120,000	40000	Mar 3 1913	4	70000.00	121,800.00	121,800.00	Coffin Valve Co	Monadnock Bldg	Mar 5 1913	May 19 1913	240	Feb 23 1914	121,000.00	A.754.35	174,724.35	147	Extra $ 724.35 to cover Bonus, Test Pit 2 Freight $ 800 paid to R Hunt for inspection Jan	56
57	Furnishing & delivering 33"x 41" Slide Gates for Hetch Hetchy Dam.	H H	6- Slide Gates complete with all operating mechanism.	Hetch Hetchy Dam.	130,000	20,000	June 2 1913	1	170000.00	170,000.00	170,000.00	Union Machine Co	624 Brannan St	June 4 1913	June 9 1913	June 24 1913	Jan 20, 1914	170000.00	4,929.82	174,929.82	225	Date of Mar 24 & Apr 21 rejected acct excessive price Extra to cover Bonus, Test Pits Freight	57
58	Furnishing & delivering 18" Balanced Valves for Hetch Hetchy Dam	H H	6- Balanced Valves complete with all operating mechanism	Hetch Hetchy Dam	155.000	50.00	Mar. 10 1913	2	188.0000	173.0000	173.0000	Wm Cramp & Sons Ship & Eng Bldg Co	Philadelphia, Penn	Mar 15 1913	Mar 15 1913	240	Feb 13 1914	Nov. 5, 1913	4.08.13	172.180.13	353	Extra $4,080.13 to cover Freight $1680 paid to R Hunt for inspection	58
59	Furnishing & delivering 18" Balanced Valves for Hetch Hetchy Dam	H H	6- Balanced Valves complete with all operating mechanism.	Hetch Hetchy Dam.	75.000	25,000	Mar 31 1913	1	98.5000	9.8.50000	9.8.50000	Wm Cramp & Sons Ship & Eng Bldg Co	Philadelphia Penn	Apr 2 1913	Apr 14 1913	240	Feb 28 1914	98,500.00	7,313.18	106,813.18	316	Extra $7,313.18 to cover Freight & Bonus	59
70		H H																					70
71	Furnishing & delivering Station Pump for Second Garrette Shaft	Mtn	1- Motor Driven Centrifugal Turbine Pump 400 gals per min	Second Garrette Shaft	1.500	500	July 25 1913	5	2.295	[illegible]	[illegible]	Allen-Camers Mfg Co	Rialto Bldg S F	July 30 1913	Aug 7 1913	85	Mar 19 1914.	1,702.00		1,702.00	236	Lowest Bid rejected acct error in estimate 160 days extension acct labor trouble	71
72	Furnishing & delivering Air Pipe	Mtn	39300 ft of 24" dia. riveted pipe made of #8 gage steel and fittings	Aqueduct Tunnels Mountain Division	8000	1.000	Aug 6, 1913	3	9598	8.[illegible]	8.[illegible]	Vandewater Pipe & Steel Co	Crocker Bldg S.F.	Aug 11 1913	Aug 13 1913	120	Nov 11, 1913	8102.10		8102.10	88		72
73	Furnishing & delivering Standard Wrought Pipe, Blk with couplings & protectors	Mtn.	5000 ft - 1" Std W.I. Pipe, Blk 3,000 " - 1½" " " " 1.000 " - 2" " " " 1,000 " - 4" " " "	Aqueduct Tunnels Mountain Division	1500	2,000	Aug [illegible]		8.[illegible]	66.[illegible]	66.[illegible]	[illegible]	46 Howard St [illegible]	Aug [illegible]	Sept 10 1913	15	Sept 11 1913	3,678.30		3,678.30	27	12 days extension acct. labor trouble	73
74	Furnishing & delivering Tie Plates	R R.	28.000 Tie-Plates for 60 lb rails of the "Harriman" type	Hetch Hetchy Railroad	560	[illegible]	Oct [illegible]	1	5 [illegible]	4.8.5.[illegible]	4.6.[illegible]	[illegible] Steel Foundries [illegible] Co	Rialto Bldg S F	Oct 6 1913	[illegible] 21 1913	10	May 8, 1914	4.496.68		4.496.68	198	155 days extension acct labor trouble.	74
75	Placing, tamping & fine ing ballast in the track of the Hetch Hetchy Railroad	R R.	Track Ballast	H H R R between Middle Fork trestle and Big Creek Camp.	[illegible]	[illegible]	[illegible] 6 1913	2	600	[illegible]	800.0	[illegible]	[illegible]	Oct 1 1913	[illegible] 16 1913	90	Dec 11, 1913	3.47.13	- 52.70	2.89.905	63	Contract called for 4 miles About 5 miles completed Contractor removed from [illegible] work [illegible] charges due City.	75
76	Furnishing & delivering 24" Air Pipe	Mtn	3205 ft. of 24" dia riveted pipe made of #11 gage steel. [illegible] inch bands made of #7 plate steel	Aqueduct Tunnels - Mtn Div.	12,000	[illegible]	Jan 18 [illegible]	[illegible]	[illegible] 43	[illegible]	43	[illegible]	[illegible] Bldg S F	Feb 6 1914	Feb 6 1914	166	Jan 29, 1914	17451.10	12,339.40	24,784.50	353	Extra $12,451.10 for 69.10 ft of pipe & 700 inch bands, authorized by Bd. of Wks.	76
77C	Construction of Aqueduct Tunnels in Mtn Div on a cost-plus-fee basis	Mtn	[illegible] crete lined tunnel 10'-3" x 10'-3" horse shoe section 18.3 mi long	Early Intake to Priest Reservoir	[illegible]	[illegible]	Apr [illegible] 1913	[illegible]	[illegible] 595 [illegible]	[illegible]	[illegible] 52	[illegible] Construction Co of America	4 Mills Bldg S.F.	May 3, 1913		1000		May 30, 1914		4.007.303.34		* Guaranteed maximum cost	77C
78																							78
79A	Furnishing & delivering Water Wheels for Moccasin Creek Power Plant.	Moc	four 25000 H.P. impulse water wheel units	Moccasin Creek Power Plant.	4 [illegible]	[illegible]	Apr 2, 1913	2	[illegible]	[illegible]	[illegible]	[illegible] Power Machine Co	[illegible] & Hunter Sts Utica, N.Y.	Apr [illegible]	May 5, 1913	[illegible]		[illegible] 9.1.13					79A
79B	Furnishing & delivering Valves for Moccasin Creek Power Plant.	Moc	Eight Gate Valves operated by Hydraulic Cylinders.	Moccasin Creek Power Plant.		10,000	Apr [illegible] 13	9	[illegible]	[illegible]	56000	[illegible] Valve Co	Monadnock Bldg	Apr 16, 1913	May 5, 1913	Feb 23, [illegible]							79B
80	Furnishing & delivering Electric Generators and Accessories for Moccasin Creek Power Plant	Moc	Four 12000 K.V.A Generators and one Motor-generator Exciter Set.	Moccasin Creek	400,000	100,000	Apr [illegible] 1913	3	304,655.00	280,285.00	280,285.00	General Electric Co	Rialto Bldg, S F	May 1, 1913	May 11, 1913	Aug 31, 1913							80
TOTALS					$ 15,350.3	$ 1,202,350			[illegible]									$ 533,500.00	$ 114,041.00 [illegible]	$ 1731350 [illegible]			

Does not include contracts not awarded.

Does not include contracts not awarded.

Includes payments on uncompleted contracts

EXPLANATION OF ABBREVIATIONS IN COL 3.
H H - Hetch Hetchy reservoir and dam
Mtn - Mountain division
R R - Hetch Hetchy Railroad.
Moc - Moccasin Creek Power Plant.

OF TANCE	FINAL ESTIMATE			ELAPSED TIME FROM BEGINNING TO ACCEPTANCE DAYS	REMARKS	CONTRACT NO.
	CONTRACT ITEMS	EXTRAS & DEDUCTIONS	AMOUNT PAID			
C 17	Col. 18	Col. 19,	Col. 20.	Col. 21	Col. 22.	Col. 23
	$10,633,535.00	$+114,861.64 -10,863.30	$10,737,530.54			
						81
						82
n 4, 1921	3490.00	150.00	3640.00	76		83
	16,726.06	19,257.61	35,983.67			84
						85
					To be paid for by Turlock Irrigation District.	86
					To be paid for by Turlock Irrigation District.	87
					To be paid for by Turlock Irrigation District.	88
	$10653,571.06	$+134,269.45 - 10,863.30	$10,772154.21			

CONTRACTS — HETCH HETCHY WATER SUPPLY

CONTRACT NO.	TITLE OF CONTRACT	DIVISION TO WHICH ASSIGNED OR CHARGEABLE	GENERAL DESCRIPTION	LOCATION OF WORK, OR LOCATION FOR WHICH MATERIAL ETC. WAS PURCHASED	ENGINEER'S ESTIMATE OF COST	AMOUNT OF BOND FOR FAITHFUL PERFORMANCE	DATE OF OPENING BIDS	NO. OF BIDS	HIGHEST BID	LOWEST BID	SUCCESSFUL BID	CONTRACTOR	CONTRACTOR'S ADDRESS	DATE OF AWARD	DATE OF SIGNING CONTRACT	TIME ALLOWED IN DAYS	DATE OF ACCEPTANCE	FINAL ESTIMATE: CONTRACT ITEMS	FINAL ESTIMATE: EXTRAS & DEDUCTIONS	FINAL ESTIMATE: AMOUNT PAID	PAGE OF VOUCHER	REMARKS	SUBSTANTIATING
Col 1.	Col 2.	Col 3	Col 4.	Col 5	Col 6.	Col 7.	Col 8.	Col 9	Col 10.	Col 11.	Col 12.	Col 13	Col 13A	Col 14	Col 15	Col 16	Col 17	Col 18	Col 19	Col 20	Col 21	Col 22	Col 23
TOTALS BROUGHT FORWARD FROM SHEET 4					$15,398,316	$1,282,359			$16,682,766.00	$ 6,589,660.42	$ 6,589,660.42							$ 6,613,535.00	$ [illegible]	$ 31,531.56			
81	Furnishing & delivering Transformers, Switchboards and Accessory Equipment for Moccasin Creek Power Plant	Moc	13-6667 k.v.a. Transformers, 6 Station Service Transformers, Switchboards, Instruments, and Switching Equipment.	Moccasin Creek Power Plant	$ 500,000	135,000			431,633.00	379,385.00	379,385.00	Westinghouse Electric & Mfg Co.											
82																							
83	Furnishing & delivering Dump Cars, Main Aqueduct, Mountain Division.	Mtn.	Ten Steel Single-side Dump Cars for muck hauling	Mountain Division tunnels	3640	$ 500	Mar 23, 1921	7	$ 3,510.00	$ 3,490.00	$ 3,490.00	Joshua Hendy Iron Works	75 Fremont St., S.F.	Apr 6, 1921	Apr 9, 1921		June 24, 1921	3,490.00	150.00	3640.00	76		83
84	Furnishing & delivering Air Pipe for tunnel ventilation.	Mtn.	10374 ft. of 24" dia. riveted pipe made of #16 gage steel 550 cinch bands made of #12 gage steel	Mountain Division tunnels.	35,984	2,500	Feb 2, 1921	2	9,238.30	16,726.06	16,726.06	Western Pipe & Steel Co of California	444 Market St., S.F.	Feb 7, 1921	Feb 9, 1921	120		16,726.06	19,237.61	35,963.67			84
85	Construction of Pulgas Tunnel	Pen.	Concrete lined Tunnel about 8500 ft long and 10 ft 3" diameter.	Through ridge between Cordilleras Creek and Crystal Springs Reservoir.	760,000	136,610	June 21, 1922	4	778,300.00	683,050.00	683,050.00	Wright, Brown & Co	208 Balboa Bldg, S.F.	June 23, 1922	July 5, 1922	500							85
86	Furnishing, delivering, & Erecting a Plate Girder Bridge at Sixbit Gulch on the Hetch Hetchy R.R.	Fthl	Single track R.R. bridge of nine 65 ft spans	Sixbit Gulch, 7mi above Hetch Hetchy Junction	32,500	6,500	July 26, 1921	5	37,247.50	32,720.00	32,720.00	[illegible] Construction Co		July 28, 1921		150						To be paid for by Turlock Irrigation District	86
87	Construction of Concrete Abutments and Piers for the Sixbit Gulch Bridge on the Hetch Hetchy R.R.	Fthl	2 abutments and 8 piers	Sixbit Gulch	28,500	8835	July 26, 1921	5	44,250.00	32,340.00	32,340.00	[illegible] Construction		July 28, 1921		100						To be paid for by Turlock Irrigation District	87
88	Grading Roadway for the relocation of the Hetch Hetchy R.R. at Sixbit Gulch	Fthl	Grading approaches to bridge	Sixbit Gulch	10,000	2,500	July 26, 1921	6	[illegible]	[illegible]	[illegible]	[illegible]		July 28, 1921		60						To be paid for by Turlock Irrigation District	88
TOTALS					$ 16,760,594 Does not include contract not awarded	$ 1,513,514			$ 17,016,554.80	$ 7,338,346.54	$ 7,338,346.54							$ 6,613,571.06	$ + 134,769.45 - 10,843.50	$ 10,777,154.21			

EXPLANATION OF ABBREVIATIONS IN COL. 3

Mtn. - Mountain Division
Moc - Moccasin Division
Fthl - Foothill Division
Pen - Peninsular Division

Report of the Bureau of Engineering

1922-1923

Department of Public Works
City and County of
San Francisco
M. M. O'SHAUGHNESSY
City Engineer

REPORT

OF THE

BUREAU *of* ENGINEERING

OF THE

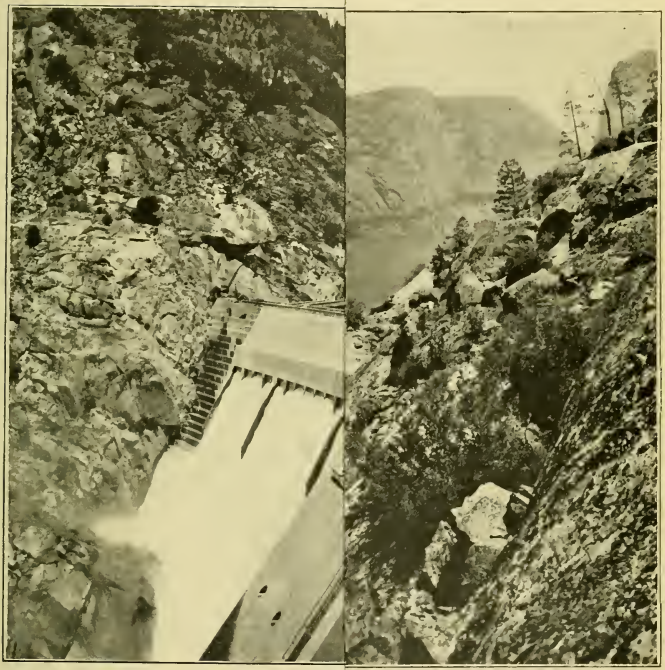
DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF
SAN FRANCISCO

FISCAL YEAR ENDING JUNE 30, 1923

JAMES ROLPH, Jr. - - - *Mayor*

TIMOTHY A. REARDON
DANIEL G. FRASER
CHARLES E. STANTON
Board of Public Works

M. M. O'SHAUGHNESSY
City Engineer



O'SHAUGHNESSY

Engineering skill and nerve of San Francisco.

O'SHAUGHNESSY DAM AND HETCH HETCHY RESERVOIR HETCH HETCHY WATER SUPPLY PROJECT

Engineering skill and nature's resources combined to form this lake of rare beauty—the future source of the water supply of the City of San Francisco.

Report of the Bureau of Engineering

DEPARTMENT OF PUBLIC WORKS

CITY AND COUNTY OF SAN FRANCISCO

1922-1923

To the Honorable
Board of Public Works
Of the City and County of San Francisco.

Gentlemen:—

I transmit herewith the annual report of the Bureau of Engineering for the fiscal year 1922-1923.

Extensions to the Esplanade, the high pressure system, and the main sewers have been made. A standard type of street signs has been placed along the main thoroughfares.

After several years of effort on our part, a definite plan for financing the Rincon Hill regrade has been approved by the interested property owners who are making a personal effort, without the City's initiative, to accomplish this work. Should they fail it will be necessary to again start proceedings under the City's mandate to inaugurate this work.

Lack of funds and the unsettled status of the proposed Market Street Railway purchase still hold back necessary extensions of the Municipal Railway System to the outer districts of the City. Plans for the Ocean View branch are under way.

Plans and estimates for construction of the Duboce Tunnel under Buena Vista Heights, which would allow for rapid transit between the Sunset District and the down town business district, have been prepared and submitted in a report to the Board of Supervisors. A similar report on the Eureka Valley-Sunset tunnel has been requested by the Board of

Supervisors and is now being prepared, and should reach a final determination by the 10th of next June.

Several new sections of the boulevard system have been started, and the improvement of existing sections has been carried on during the year in order to provide for the ever-increasing motor traffic in this City. Preliminary surveys have been made for the Bay Shore Highway, being the first steps in providing another main highway and outlet from San Francisco down the Peninsula.

The amount of street improvements completed under contracts under the plans and supervision of this Bureau, was almost double in value of preceding years. Several local district special treatment improvements, which will overcome some of the difficulties caused by a rectangular system of streets on steep hillsides, are now under construction.

While satisfactory progress has been made on all sections of the Hetch Hetchy Project now under way, the outstanding feature of the year's work is the completion of the O'Shaughnessy Dam. Our worthy Mayor, James Rolph, Jr., at the recent dedication of this dam has graciously referred to it as "the master work of a great career, destined to stand throughout the centuries as one of the mightiest structures built by man." It is the largest single structure in the State of California or the entire west coast.

Another important phase of the Hetch Hetchy Project—one involving both policy of operation and construction—has been the subject of investigation and reports during the past year. In anticipation of the completion of the Moccasin Creek power house next year, a plan and methods for disposal of the power output of the system must be decided on immediately. Because of the value of the power to be developed, this phase of the project is of great interest and therefore I am embodying in full, in this report to you, two reports on this subject made by me to the Board of Supervisors. Although the latest report was made after the close of the recent fiscal year which this annual report covers, the

importance of the power disposal question and the close relation of the two reports on the subject, prompts me to include it.

The City of San Francisco is to be congratulated on the magnificent work accomplished along the project. Difficulties of an almost insurmountable nature were encountered in sinking the Second Garrotte shaft and were overcome by the fidelity of the City's employees engaged on the project. Sixteen hundred and fifty gallons of water per minute were encountered in the sinking of this shaft and numerous pumping stations had to be arranged at different levels to meet those difficulties. All of the 18 miles of tunnels, except one, are practically completed and the alignment developed was most successful. The same engineers, Messrs. McAfee, Ryan, and Best, who were successful on the Stockton Street and Twin Peaks Tunnels, represent the City on this work.

The Priest forebay dam is completed inside the City's estimates in practically the time of one and one-half years. By the first of Januaryy, 1925, it is the hope to have the enormous power plant at Moccasin Creek entirely completed, making energy available for the use of the citizens of San Francisco.

Two very faithful employees of this Department, Mr. C. H. Holcomb and Mr. B. D. Rickey, were buried this year and were a serious loss to the City office.

Conspicuous loyalty has been displayed by all the municipal employees on the Hetch Hetchy Project, each working to do their very best for the interests of the citizens and taxpayers to make this project a pronounced success.

Respectfully,

M. M. O'SHAUGHNESSY,

City Engineer.

IN MEMORIAM

FREDERICK M. HYDE
Engineering Draftsman
Service—14 years
Died—October 29, 1922

JAMES REAVY
Engineering Chemist's Assistant
Service—18 years
Died—November 10, 1922

CHARLES H. HOLCOMB
Assistant Civil Engineer
Service—34 years
Died—January 25, 1923

LOUIS D. SLOSS
Clerk
Service—19 years
Died—March 25, 1923

WILLIAM D. EVANS
Surveyor's Field Assistant
Service—23 years
Died—May 20, 1923

BLISS D. RICKEY
Surveyor's Field Assistant
Service—23 years
Died—June 3, 1923

BOULEVARDS, STREETS AND HIGHWAYS

Several sections of San Francisco's excellent boulevard system have been completed during this fiscal year, namely:

Market Street Extension, Mono Street to Twenty-fourth Street;

Sloat Boulevard, northerly half, Nineteenth Avenue to Thirty-fifth Avenue;

Great Highway, westerly half, Cabrillo Street to Fulton Street.

In addition, construction was started on two other sections which, when completed, will provide for the traffic over them, magnificent panoramic views of the City, bay and ocean and which will rightly share the world-wide renown of Twin Peaks Boulevard, the Great Highway and other sections of our boulevard system as scenic highways. The two sections under way are the Telegraph Hill Boulevard, circling the landmark of that name, and the boulevard from Lincoln Park to Sutro Heights.

Also several local special treatment improvements were under construction, the most important being the Liberty and Sanchez Street improvement and the Collingwood and Twenty-first and Twenty-second Street improvement.

The cost of street improvements constructed under public, private and City pay contracts during the year was approximately $1,400,000.00. Among these improvements were the following:

Valley Street, Noe Street to Castro Street;

Bay Street, Van Ness Avenue to Laguna Street;

La Plaza, Balboa Street to Fulton Street;

Taraval Street, Thirty-seventh Avenue to Forty-eighth Avenue.

Mission Terrace.

RECONSTRUCTION OF MARKET STREET
Showing raising of street and car tracks—north side completed, south side under construction.

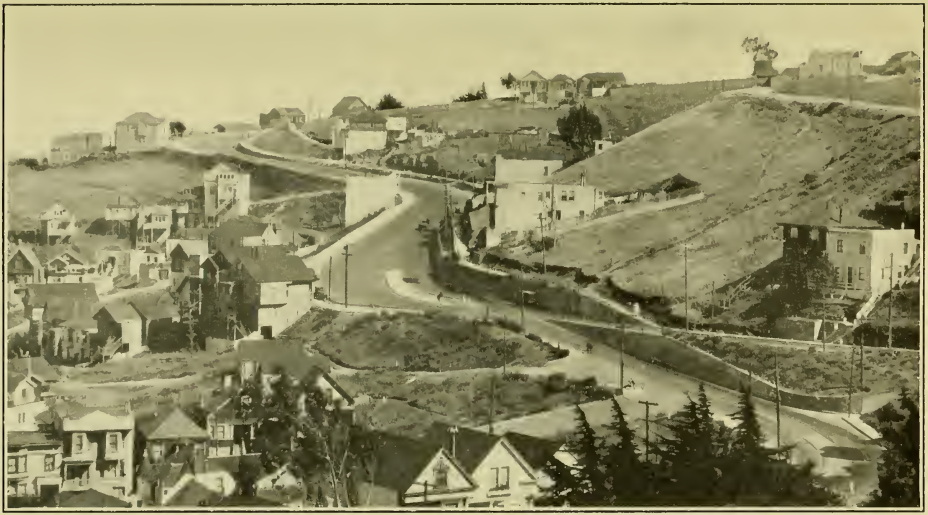
The reconstruction of Market Street from The Embarcadero to Sansome Street, by the Bureau of Street Repair and the Market Street Railways, is being done with the co-operation of this department. Complete working diagrams and profiles were prepared for this work, which involves the raising of the tracks and street to the official grade. As this street has been settling at an approximate rate of 1½ inches a year, there has been a maximum settlement of two feet in some places since the last reconstruction in 1907, thus making this a work of some magnitude. While the modern large buildings adjoining this street have been constructed on piles, many of the older and smaller buildings have not this solid foundation and consequently have also settled. The bringing up of the street to grade will necessitate reconstruction of sidewalks by the owners, and, in many cases, rearrangement of entrances and floor levels. Special study has been given this problem in order to produce the desired result with the least possible disturbance of the existing improvements.

Besides Market Street, the reconstruction program of the Bureau of Street Repair called for an expenditure of approximately $350,000.00, for all of which reconstruction this office prepared working diagrams. Jones Street, from Golden Gate Avenue to Post Street, and McAllister Street from Franklin west, reconstructed and widened by reducing sidewalk widths, involved considerable study and fitting of grades to existing improvements.

Market Street Extension:

Market Street Extension is part of the direct route from the Ferry Building to the junction of Junipero Serra and Sloat Boulevards, connecting the southwestern residential section with the main business section of the City, and also providing a new main thoroughfare out of the City, connecting with the present peninsula highways, thus relieving the present congested streets of the City from some of the peninsula-bound traffic.

MARKET STREET EXTENSION, MONO STREET TO TWENTY-FOURTH STREET
Before improvement, showing location of road (looking north)



MARKET STREET EXTENSION, MONO STREET TO TWENTY-FOURTH STREET
After improvement (looking south)

The paving of this thoroughfare from Mono Street to a junction with Corbett Avenue at Twenty-fourth Street was completed at a cost of about $80,000.00. This section was formerly known as Falcon Avenue. In addition to purchasing the necessary land for widening this section of Market Street and assuming the cost of grading and sewers and retaining walls, the City has paid almost half the cost of the paving under this last contract. The property owners were assessed only up to a rate of $10.00 per front foot for the paving of this boulevard.

Land is being acquired and plans and specifications prepared for the construction of the connecting link between this upper section and the lower section of the Market Street Extension. Meanwhile, traffic is routed over Eighteenth Street and Falcon Avenue between the two improved sections.

Sloat Boulevard:

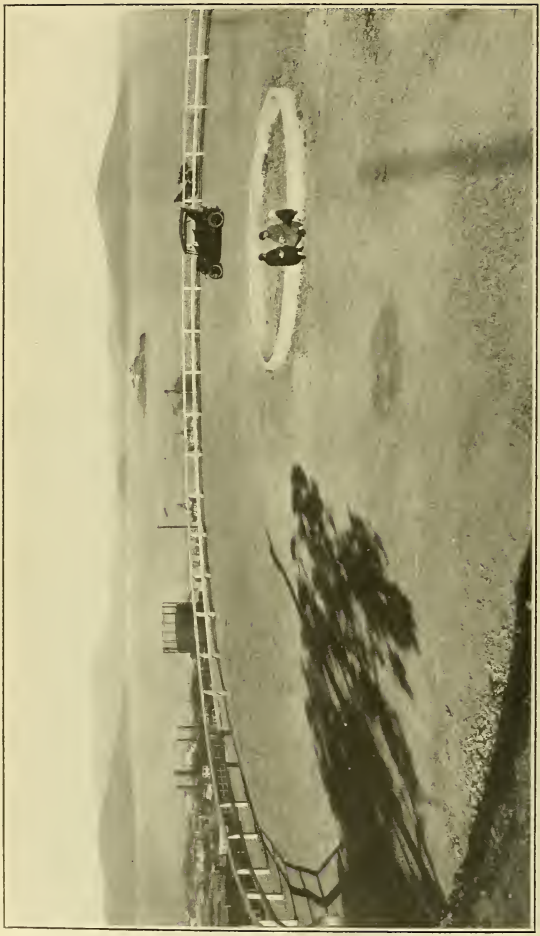
The double roadway of Sloat Boulevard for its entire length is now paved, being completed by the recent contract which covered the northerly half between Nineteenth and Thirty-fifth Avenues.

A contract for the improvement of the junction of Sloat Boulevard, Great Highway and the Skyline Boulevard has been awarded and construction is now under way. One of the principal features of this improvement is an underground pedestrian passageway beneath the southerly paved strip of Sloat Boulevard from a ramp at the terminus of the street railway line and leading to the new Municipal Playground and Swimming Pool. With the completion of the Skyline Boulevard and the playground and pool, this junction will be called upon to carry a large amount of automobile traffic, especially on Sundays and holidays.

Great Highway:

The improvement of the Great Highway between Point Lobos Avenue and the North Drive in Golden Gate Park to the full width of 150 feet will soon be complete, the last

SLOAT BOULEVARD
Looking east, showing completed pavement.



TELEGRAPH HILL BOULEVARD
Parking Circle at top of Telegraph Hill.

contract for paving the westerly portion between Fulton and Cabrillo Streets having been completed during this fiscal year. Bids are now being called for the extension of the paving on the westerly portion from Fulton Street southerly, fronting on the recently completed Section "D" of the Esplanade.

Telegraph Hill Boulevard:

Beginning at Kearny and Lombard Streets, this boulevard winds about Telegraph Hill at a maximum grade of 9 2-3%, for a length of approximately 1450 feet, and ends in a parking circle at the peak of the hill. The width of finished roadway will be 22 feet, widened to 27 feet on the sharpest curves.

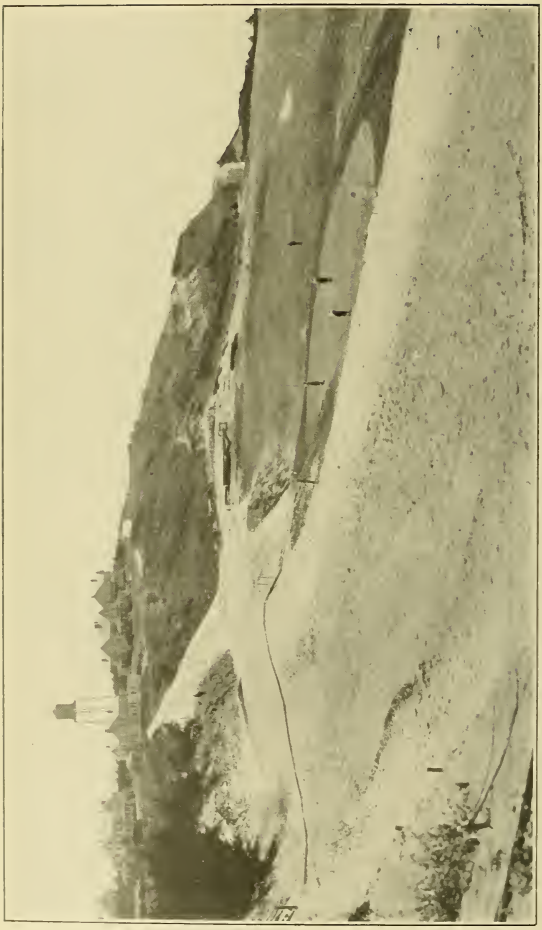
From the parking circle at the top of the hill, the motorist will have a wonderful view of the northeasterly sections of the City, including the docks and shipping, of San Francisco Bay and the Golden Gate, and of Sausalito and the East Bay communities. The City has purchased additional lands on the hill, necessary for the road, and will assume the total cost of this improvement.

The present contract includes the grading of the road and drainage ditches, and construction of walls, guard fence and catch basins. Paving of the road will be done under a separate contract the following year, after allowing the fills to settle sufficiently.

Lincoln Park Boulevard:

Unlike Telegraph Hill Boulevard, which is in itself a unit of the City's system of boulevards, the road under construction through Lincoln Park is a connecting link in the twenty-mile drive circumscribing the entire western half of the City, of which the Marina, Camino del Mar, Point Lobos Avenue, Great Highway, Sloat Boulevard, Portola Drive, Twin Peaks Boulevard, Market Street and Van Ness Avenue are component parts.

This section connects with the recently paved Point Lobos Avenue at Forty-eighth Avenue, from which point it



LINCOLN PARK BOULEVARD
Grading for highway adjacent to Municipal Golf Links.

runs northerly to the northwesterly corner of Fort Miley Military Reservation and thence easterly along the cliffs, between the northerly boundary of the Reservation and the tracks of the Market Street Railway and through the Municipal Golf Links in Lincoln Park, joining the present road in Lincoln Park near the new Legion of Honor Memorial Building. Traversing this boulevard, one has a view of the Pacific Ocean and the Golden Gate, which has formerly been denied the motoring public through lack of a highway along these cliffs.

The length of this section is 4300 feet and the maximum grade 6.58%, the grade over the greater length being less than 4%. The width of the graded road will be 60 feet, which will allow a 50-foot roadway with a 10-foot walk on one side.

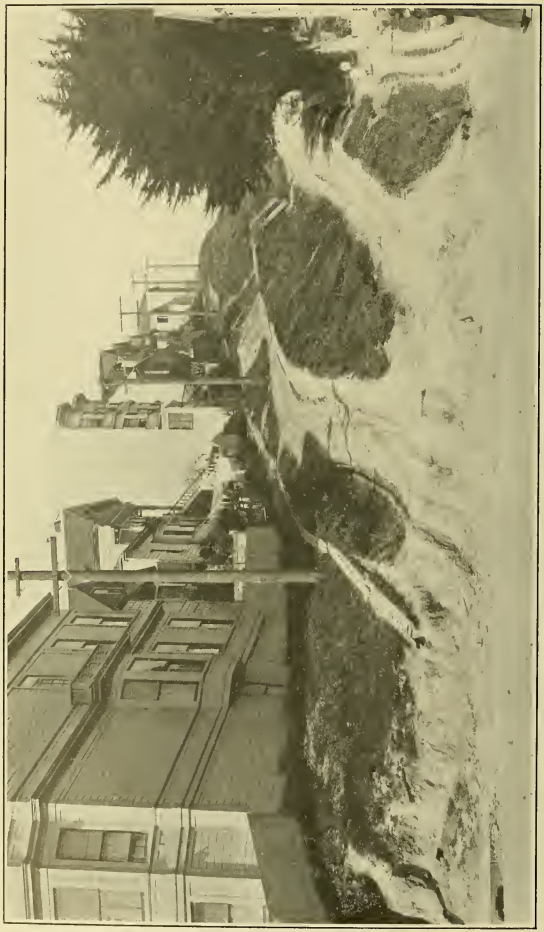
The contract now under way includes grading, gravel surfacing, guard fence and drainage and two small sections of retaining wall. The grading includes approximately 60,000 cubic yards of cut, and over 3,000 cubic yards of gravel surface will be laid. Permanent pavement will not be laid until the new fills shall have become stable.

Signal apparatus in the United States Reservation had to be moved and arrangements made with the War Department for this purpose.

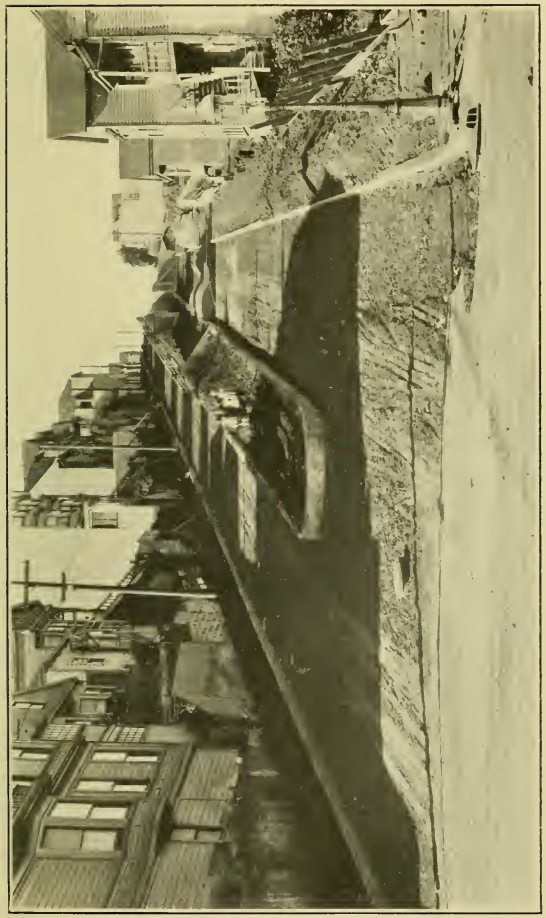
Special Street Improvements:

The grading and construction of retaining walls on the **Liberty Street** (Church to Noe Street) and **Sanchez Street** (Twentieth to Twenty-first Street) improvement, as described in the last report, were completed. The paving of these blocks will be placed during the coming year, as the sum of $37,000.00 has been included in the Municipal budget for 1923-24 for this purpose.

Another local special treatment improvement similar to the Liberty and Sanchez Street improvement is located on **Collingwood Street** from Twentieth to Twenty-second Street and **Twenty-first** and **Twenty-second Streets** from



LIBERTY STREET, LOOKING WEST FROM CHURCH STREET
Before improvement.



LIBERTY STREET, LOOKING WEST FROM CHURCH STREET
After grading and construction of walls.

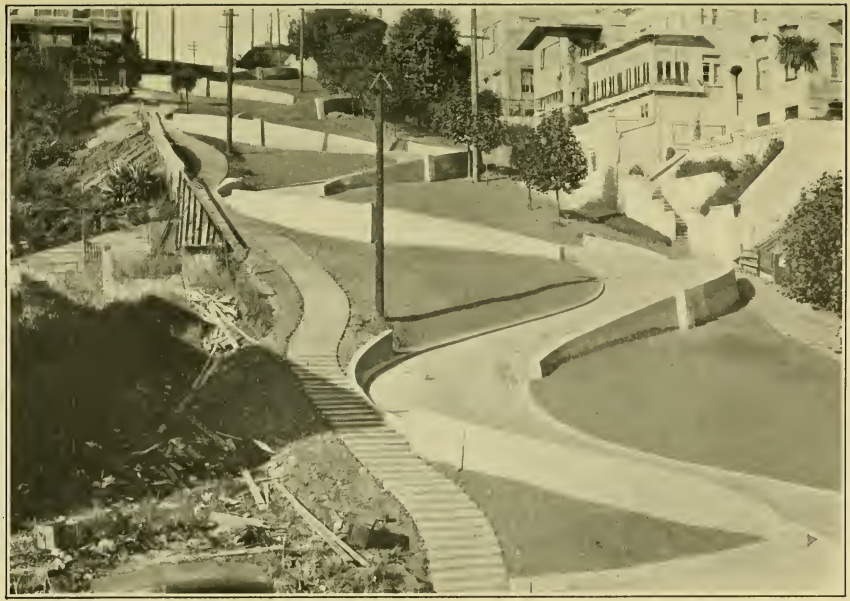
Castro to Diamond Street. These are typical illustrations of streets in a rectangular system on steep hillsides. That the owners of the abutting properties have built homes without regard to any plan for street grades and improvement, added to the difficulties of the problem. Many different plans were drawn up and rejected by the property owners before the final plan, under which the improvement is proceeding, was adopted. Even with this plan, some of the property owners protested against the improvement. By means of retaining walls, double roadways and steps, passable grades for traffic and pedestrian travel have been evolved. The grading, sewers and walls and stairs are being done under the present contract, at an estimated cost of $70,772.00, towards which cost the City has appropriated the sum of $22,500.00. Included in the City's budget for 1923-24 is the sum of $34,000.00 for the paving of this improvement.

Plans for the improvement of **Lombard Street** between Hyde and Leavenworth Streets were prepared by this office and the work was done by the Bureau of Street Repair. This improvement, consisting of a winding brick pavement, 15 feet in width, supported by curving retaining walls, has resulted in a 19% grade in place of the almost impassable 26% grade of the old cobblestone straight roadway.

Proposed Boulevards and Local Improvements:

San Francisco's quota for 1923-24 from the State funds collected through the licenses and taxes of motor vehicles will aggregate approximately $700,000.00. It is proposed to expend this sum as follows:

Bay Shore Highway—to be used by State Highway Commission	$500,000.00
Skyline Boulevard (Joint Highway Dist. No. 1) Fencing	30,000.00
Virginia Avenue Widening	30,000.00
San Jose Avenue Widening, Cotter St. to Geneva Avenue	18,000.00
Avalon Avenue Extension	20,000.00
Silver Avenue, Mission Street to San Bruno Avenue	25,000.00
Marina Boulevard	80,000.00



LOMBARD STREET, LEAVENWORTH STREET TO HYDE STREET
Winding roadway on 19% grade replaces old 26% cobble stone pavement.

Bay Shore Highway: Through concerted action of the Supervisors of San Francisco and San Mateo Counties, a tentative highway district comprising the two Counties was formed for the construction of a highway from San Francisco through San Mateo County and also including a connection to and a proposed bridge across San Francisco Bay near Dumbarton Point. In order to facilitate the preliminary work, the project was divided into sections, this County, San Mateo County, and the State Highway Commission each being given a section on which to prepare preliminary surveys and tentative plans and estimates. This department prepared a report covering the northerly section from Army Street and Potrero Avenue in this City to San Mateo; the report of the San Mateo County Engineer covered the section from San Mateo to Redwood City, and the connection to and the proposed bridge were reported on by the State Engineer.

The following is a copy of the report of this department as submitted to the Board of Directors of the Joint Highway District:

"San Francisco, August 24, 1922.

To the Joint Highway District No. 4:

Gentlemen:

Pursuant to a meeting held on June 29th in the Division Headquarters of the State Highway Commission, in San Francisco, and participated in by your Commission, the Chief Engineer of the Highway Commission, the County Engineer of San Mateo County, the Highway Commission of the State of California and Assistant Engineer C. E. Healy, of this department, it was agreed that the work of making the necessary preliminary surveys and estimates of cost for the construction of the proposed highway from the intersection of Potrero Avenue and Army Street in San Francisco, through San Francisco and San Mateo Counties via Dumbarton Cut-off to a point on the main highway through Alameda County near Niles, should be divided as follows:

San Francisco to have the section between Army Street and Potrero Avenue and South San Francisco, County

Engineer Kneese of San Mateo County, the section between South San Francisco and Redwood City, and Mr. Fletcher, the State Engineer, the section between Redwood City, Dumbarton Cut-off and a connection with the main highway in Alameda County near Niles.

Before starting this work, I made a thorough study of the traffic conditions of today and the anticipated future needs of this city and the adjacent county and the effect that the proposed road would have in the growth and development of the contiguous territory. I decided that a right-of-way 125 feet in width should be acquired at this time, which would ultimately permit of 100-foot permanently paved roadway with 12½-foot sidewalks.

It is obvious that a complete program of this magnitude could not be undertaken at this time, as it would be difficult to finance, and in the estimate that I have prepared, I have provided for the initial acquisition of the full width right-of-way, the grading of this entire right-of-way wherever the costs were not prohibitive, the construction of macadam pavement on the finished fill 40 feet in width and 6 inches thick, which would carry the traffic for a period of at least two years, the time necessary for the proper settlement of the fills. At the end of this period, I have provided that the macadam pavement should be topped with a permanent concrete pavement 40 feet in width, 11 inches in thickness at the shoulders, 8 inches on the crown with 8-foot shoulders. (A detail of this construction is incorporated in the report to follow.)

The distance from Potrero Avenue and Army Street to the overhead crossing of the Southern Pacific Railroad at South San Francisco, by the proposed line is 7½ miles and the distance between South San Francisco and San Mateo is 7 miles. As a comparison, the distance between San Mateo and Fifth and Market Streets, via the State Highway and Mission Street, is 17.7 miles. The distance of the new road between the same points is 14½ miles. The new road, therefore, is 3.2 miles shorter. There will be no grades on the new road in excess of 6% and the curves will be of long radius, making it safe for traveling, and with the overhead crossing at South San Francisco all level grade crossings of the Southern Pacific lines will be eliminated.

In closing, it is my belief that the construction of this road is of primary importance for the relief of congestion and should be speeded up as fast as possible. I think,

however, that the undertaking is of more than local importance and that a portion of the cost should be borne both by the State and Federal Governments.

Enclosed please find detailed estimate of the proposed line, maps showing alignment and a detail of the proposed permanent construction.

Respectfully,

(Signed) M. M. O'SHAUGHNESSY,
City Engineer."

ESTIMATE FOR PROPOSED NEW HIGHWAY.

125 foot right-of-way. 100 foot paved.

		1st Installation of Construction
Potrero Avenue and Army Street to County Line	2.80 miles	$1,500,000
County Line to South San Francisco	4.70 miles	936,000
South San Francisco to San Mateo	7.00 miles	1,036,000
	14.50 miles	$3,472,000

The Board of Directors of the district submitted a report to the Board of Supervisors of San Francisco and San Mateo Counties in which the following description of the tentative route of the proposed highway was given:

"Within the City and County of San Francisco, commencing at or near the intersection of Potrero Avenue and Army Street and thence southerly and easterly over existing highways, the same to be widened, straightened, extended and new grades established and reconstructed where necessary to the county line between said City and County of San Francisco and the County of San Mateo; thence in the same general direction partly over new and partly over existing highways and connecting the same where necessary, extending, widening, straightening, regrading and reconstructing such existing highways where necessary or convenient to a point in the vicinity of South San Francisco; thence along the easterly side of the Southern Pacific Railroad tracks in San Mateo County through

Burlingame to a point near the intersection of Bay View Avenue and Howard Street in the City of San Mateo; thence southeasterly along Bay View Avenue to its southerly termination; thence in an approximately straight line to a connection with the Beresford road at or near its northerly termination; thence along said Beresford road to a point near the northerly limits of Redwood City; thence southerly on a convenient curve or line, crossing Redwood Creek immediately southerly of the S. H. Frank & Co. tannery and continuing in as direct a line as possible to a connection with the Middlefield road near the southeasterly limits of Redwood City; thence along the Middlefield road to the southern line of San Mateo County; also from a point on the line of said highway in Redwood City to near the railroad track running from said city to the Dumbarton bridge and paralleling said tracks as nearly as practicable, keeping southerly from Ravenswood Slough to a point on the southwesterly side of San Francisco Bay, and a bridge across said bay to a point near the mouth of Baird Creek on the northeasterly side of said bay."

The total approximate cost was estimated at $7,000,000, based on a proposed acquisition of right of way 125 feet wide and the construction of a paved highway 40 feet wide and a bridge of steel construction on concrete piers. The cost was to be borne by the two Counties in the ratio of their assessment rolls—San Francisco's portion being $6,600,000, and San Mateo's portion $400,000.

Arrangements between the two Counties, however, were not consummated and instead the Board of Supervisors of the City and County of San Francisco authorized an appropriation of $500,000 from the County Roads Fund to institute a start on the highway by the State Highway Commission of California. A bill was recently passed by the Legislature providing that this county may turn over a part of its automobile tax money, received from the State, to the State Highway Commission for the construction of connecting highways in San Mateo County.

Rights of way and plans will proceed on the basis of ultimately having a road 100 feet in width, with 12½-foot walks on either side, and of a type of construction that

will be the most perfect in highway work. The preliminary construction contemplates a 40-foot pavement at this time, to be widened as necessity requires. The entire project, when fully completed, will involve about 28 miles of construction, including that part within the City and County of San Francisco from Potrero Avenue and Army Street, and reaching to the Santa Clara County line.

San Jose Avenue: The amount of $18,000 contributed by the City towards the widening and improvement of San Jose Avenue between Cotter Street and Geneva Avenue is in accordance with the plan of improving this thoroughfare, under which plan the section between Sickles Avenue and the County Line has recently been completed. The owners of property needed for widening the street deed the necessary land and the City, in turn, assumes a part of their liability for paving, equal in amount to the value of the land taken. The improvement of the intermediate section, between Geneva Avenue and Sickles Avenue, cannot be made until the construction of new viaducts across the railway tracks at Sickles Avenue and at Mount Vernon Avenue.

Marina Boulevard: One of the many districts of the City which is rapidly being built up, is located on the Panama-Pacific Exposition site and fronting on the Marina Boulevard. The Board of Supervisors have adopted a resolution favoring the establishment of a building and grounds for industrial expositions at the Marina, and to initiate this development and improvement have included the sum of $100,000 in the budget for the coming year.

The making of a rock fill along the Marina Boulevard fronting on the Yacht Harbor has been under way—a contract for the same having been let. Over 22,000 tons of massive rocks have been dumped along the shoreline, forming a seawall behind which a fill will be placed to carry the boulevard. During the coming year, the sections on each side of the fill will be paved, funds for this being

provided as shown above. Following reconstruction of a short section of wood stave pipe sewer and the settlement of the fill, this intervening section will be paved, giving a continuous wide roadway along the bay shore from Fort Mason to the Presidio.

Silver Avenue: Silver Avenue is a through route of easy gradient between Mission Street and San Bruno Avenue and when paved will divert traffic between these highways. It is planned to grade the street and lay a 20-foot concrete roadway with necessary culverts and drainage appurtenances. Because of its importance as a cross-connecting thoroughfare between two main traveled routes, the City will contribute the sum of $25,000 towards the improvement and the property owners will pay the balance of the cost.

Avalon Avenue: The extension of Avalon Avenue from Lisbon Street to Mission Street through the lands of the Hebrew Home for the Aged will provide a short cut from Mission Street to the district east of the Home. The Trustees of the Home will donate the land necessary for the roadway, provided the Home is not assessed for the street improvement, and as the opening and paving of this street will be of benefit to a large territory, the City will pay the cost of paving the same.

Virginia Street: Another similar proposed and desirable improvement in the Mission District is the widening of Virginia Avenue from Mission Street to Coleridge Street. This street is the only easy gradient outlet to Mission Street for the surrounding district, but in this block it has only a width of 20 feet. In order to widen this to 60 feet, property must be purchased, so the City will share equally with the property owners of an assessment district to be formed to pay the costs of the property and improvement.

Market Street Extension Tributaries: The main thoroughfares tributary to the Market Street Extension are

being studied preparatory to improving them. **Grand View Avenue,** one of the principal of these thoroughfares, provides a low grade connection between the Mission District and the Market Street Extension. Plans are being prepared for the improvement of Grand View Avenue with a two-level roadway, with grades less than 10%. **Corbett Avenue** from Twenty-fourth Street to Caselli is another tributary thoroughfare of the Market Street Extension, plans for the improvement of which are being drawn up.

Special Treatment Improvements: Caine Avenue from Lakeview Avenue to Ridge Lane, **Havens Street** from Leavenworth Street westerly, and **Vulcan Street** from Lower Terrace to Ord Street, are special treatment improvements for which plans were prepared and proceedings started.

Diagonal Street in Potrero Hills: Plans have been developed for a low grade diagonal street in the Potrero Hill section, connecting Rhode Island Street to Carolina Street between Twentieth and Twenty-second Streets. The grades of the present connecting streets in this vicinity, Nineteenth, Twentieth and Twenty-second Streets, range between 19% and 37%—grades which are prohibitive to heavy traffic and almost inaccessible for fire protection equipment. To carry out the proposed plan of a 60-foot thoroughfare with a grade of 3½% and including acquisition of property and payment of damages, will cost approximately $100,000.

STREET WORK PERFORMED UNDER CONTRACTS

July 1, 1922—June 30, 1923.

	Quantity	Cost
Asphalt Pavement, 6″ concrete base		
Wearing surface 2″	55 sq. yds.	$ 139.64
Asphaltic Concrete Pavement, 6″ concrete base		
Wearing surface 1½″, paint coat	255,816 ″	642,403.86
Asphaltic Concrete Pavement, with vitrified brick strip, 6″ concrete base		
Wearing surface 1½″, paint coat	14,909 ″	33,671.73
Vertical fibre brick	6,081 ″	32,071.80
Asphaltic Concrete Pavement		
Wearing surface 1½″, minimum(conform)	381 ″	360.69
Surface on Viaduct	7 tons	72.00
Asphaltic Binder Fill	6,042 sq. yds.	5,190.57
Concrete Pavement, 6″	21,306 ″	59,705.04
Basalt Block Pavement, asphalt and gravel filler		
On 6″ concrete base	470 ″	2,453.89
On sand, (conform)	13 ″	11.50
Broken Rock Pavement	614 cu. yds.	962.33
Gutter		
Concrete	447 sq. yds.	1,921.18
Vitrified brick	66 ″	360.64
Curb		
Granite (new)	92 ft.	197.10
″ (reset)	594 ″	340.37
″ (redressed and reset)	2,180 ″	1,744.00
Concrete, armored (new)	120,136 ″	130,550.07
″ ″ (reset)	27 ″	7.79
″ ″ special 8″	473 ″	638.55
Wheel Guards, Concrete	2,712 ″	1,337.88
Coping, Concrete	839 ″	1,765.47
Headers, Redwood	11,007 ″	618.40
Sidewalks		
Artificial Stone	24,600 sq. yds.	39,883.93
6″ Reinforced Concrete	1,171 ″	3,579.63
Asphalt	101 ″	120.92
Grading		
Cut	148,530 cu. yds.	161,988.07
Fill	27,093 ″	19,314.97
Pipe Railings	2,197 ft.	8,843.00
Walls, Stairways, etc.		
Retaining walls concrete		27,821.85
Rubble walls, mortared	6,381 cu. yds.	48,019.48
″ ″ dry	450 ″	1,801.99
Viaduct, concrete		17,741.71
Parapet, concrete	664 ft.	4,896.20

Walls, Stairways, etc. (cont'd)	Quantity	Cost
Steps, concrete	24 flights	3,304.20
" wooden	1 flight	412.50
Post footings, concrete	123	184.50
Safety Station	1	1,000.00
Posts, Steps, Entrances, etc., concrete		1,502.84
Miscellaneous		
Spreading Loam		546.80
Removing Trees		500.00
Ditches and Drains		947.92
Miscellaneous Grading, Clean up, etc.		1,525.82
Sewers—Ironstone Pipe		
6" (side sewers)	2,878 ft.	3,589.40
8"	12,976 "	29,022.78
10"	540 "	1,748.07
12"	5,606 "	18,218.95
15"	4,459 "	14,690.37
18"	679	2,681.00
21"	625 "	2,643.75
Sewers—Concrete		
2' 6" x 3' 9"	140 "	1,876.00
2' 6" x 2' 9"—on piles	196 "	3,733.50
3' 0" x 4' 6"	618 "	9,826.20
Taper Connections	1 "	200.00
Y's—on I. S. P. Sewer		
On 8" Sewer	768	1,244.86
" 12" "	276	538.85
" 15" "	72	131.25
" 18" "	11	33.00
" 21" "	34	102.00
Manholes		
On I. S. P. Sewers	107	12,180.00
" Concrete Sewers	6	540.00
Lampholes	4	125.00
Catchbasins		
New	200	25,641.20
Reset	25	1,811.00
Stormwater Inlets	5	351.96
Culverts—10" I. S. P.	5,435 ft.	10,954.61
Underdrain—8" I. S. P.	194 "	155.20
Piles	1,794 "	1,794.00
Traps & Risers		
New	76	347.50
Reset	39	312.00
Total Costs		$1,404,963.28

Summary—Cost of Street Work

Work under public contracts	$ 671,444.65
" " private "	412,354.69
" " City pay	321,163.94
Total	$1,404,963.28

SEWERS

Army Street Sewer Extension:

Drainage conditions in the lower Islais Creek district will be greatly remedied on completion of the section of the Army Street Sewer extension, now under construction. The sanitary flow of that district, covering approximately 1000 acres east of the North Point main sewer at Mission Street, as well as the storm flow of the upper section of the North Point main, will be carried into Islais Creek Channel opposite Mississippi Street. At the present time, the outlet of the Army Street sewer is in Islais Creek at Kansas Street. The extension of this sewer will permit the development of a large industrial district along Islais Creek between San Bruno Avenue and the Southern Pacific Railway trestle.

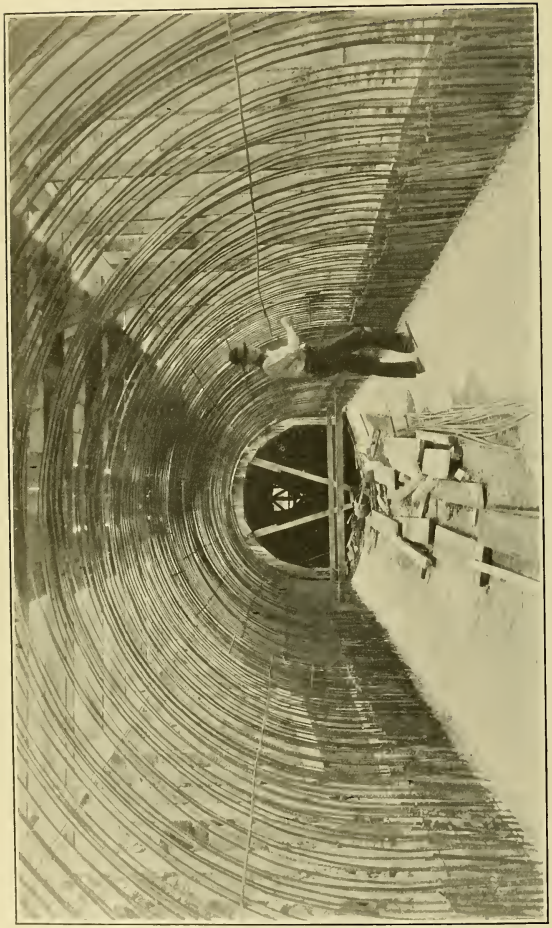
The present construction will extend the sewer 2326 feet, consisting of 896 feet of 8 ft. 6 in. by 10 ft. 6 in. basket-shaped reinforced concrete sewer, and the balance, 8 ft. by 10 ft. flat top, partly on piles. A further extension of 263 feet of 8 ft. by 10 ft. flat top sewer and 100 feet of bulkheaded ditch will be necessary to carry this outlet to the Channel, and will be built upon completion of the present contract. Lack of available funds prevented the including of the total length in one contract, but funds for this purpose will be included in the budget for 1923-24.

Great Highway Sewer:

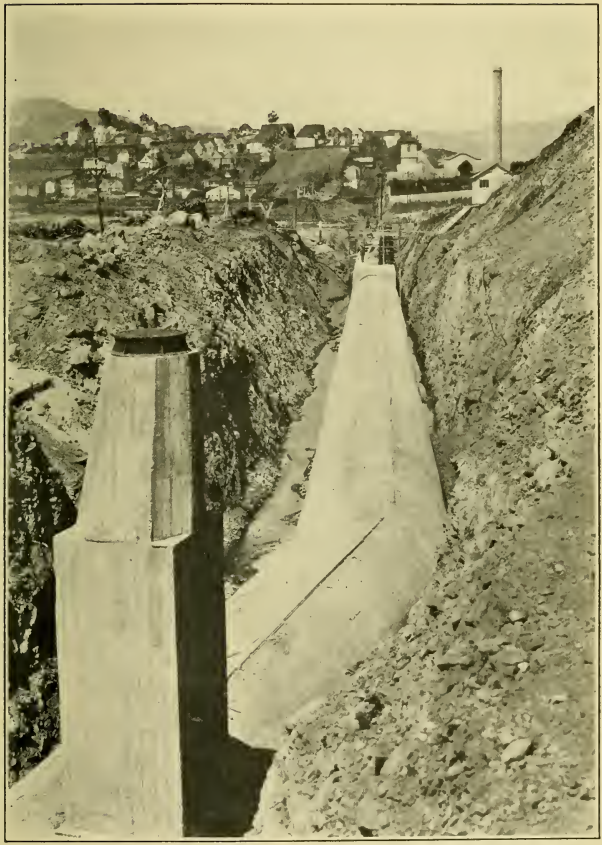
The sewer in the Great Highway was extended southerly from Noriega Street by the construction of 618 feet of 3 ft. by 4 ft. 6 in. and 140 feet of 2 ft. 6 in. by 3 ft. 9 in. reinforced concrete sewer and the necessary taper connection and appurtenances.

Septic Tank—Bay View District:

To take care of local sanitary conditions in a portion of the Bay View district until improvements will warrant



ARMY STREET SEWER EXTENSION
Showing concrete invert and reinforcement of walls and arch.



ARMY STREET SEWER EXTENSION
8-ft. 6-in by 10-ft. 6-in. basket shaped and 8-ft. by 10-ft. flat top reinforced concrete sewer.

a complete separate system of sewers in this district, a septic tank has been designed and is now under construction at Griffith Street and Fitzgerald Avenue.

Side Sewers:

The collection of deposits for and the supervision of installing side sewers was taken over by this department at the beginning of the fiscal year. Two thousand and eighty applications with deposits totaling $154,017.45 were received during the past year, many of the applications covering two or more side sewers. It has been necessary to employ 30 crews on the installation of side sewers in order to keep up with the number of applications.

Deposits Received for Sidesewers

1922	No. of Applications	Amount
July	129	$ 8,973.25
August	201	15,524.00
September	176	12,477.40
October	200	14,651.95
November	167	12,266.50
December	141	10,533.00
1923		
January	149	11,588.30
February	160	11,996.25
March	197	14,908.90
April	191	14,727.75
May	184	13,312.25
June	185	13,057.90
Total	2080	$154,017.45

The repaving over side sewer trenches under a contract was found unsatisfactory and by recommendation of this office, special crews were employed to place the concrete base and the cover is placed by the Street Repair Department of the City.

The increase in efficiency on this work is shown by the decrease in cost to the owners—larger refunds on deposits being made now than in previous years in nearly all installations.

Proposed Sewers:

Included in the budget appropriations for the coming year are funds for reconstructing the sewer in **Sixth Street** between Brannan and Townsend Streets; for replacement of the temporary wood-pipe sewer in **Tonquin Street** (Marina Boulevard) between Broderick and Divisadero Streets by a permanent 2 ft. by 3 ft. concrete sewer; and, as noted above, for the construction of the outlet for the **Army Street sewer extension.** Plans and specifications have been prepared for this work and contracts will be awarded as soon as the funds are available.

MISCELLANEOUS CONSTRUCTION

Street Signs:

Four hundred and sixteen street signs of the standard type adopted last year have been erected. On some of the most important thoroughfares, such as Lincoln Way, Fulton Street, and Geary Street, signs were placed for their whole length, while the signing of the business district was extended to Divisadero Street on the west, and Sixteenth Street on the south.

With a slightly larger appropriation ($10,000) in the new budget for 1923-24, signs will be erected in several neighborhood business districts and along more of the main thoroughfares, as San Bruno Avenue, Railroad Avenue, Mission Street, Ocean Avenue, and Nineteenth Avenue.

Pedestrian Walk:

The Board Walk along the Great Highway was extended northerly a distance of 6,178 feet, thus providing for pedestrians a safe promenade overlooking the Ocean beach from Sloat Boulevard north to Judah Street.

Esplanade:

Another unit of Esplanade, Section "D", 326 feet in length, has been completed, making a total continuous length of 2,066 feet of Esplanade now constructed.

It is found that the amount usually made available for Esplanade construction in any one year is insufficient to allow economical construction, as in small units the ratio of equipment and plant costs to total cost is exceedingly high. Therefore, this Department does not anticipate letting a contract for further extension of the Esplanade during the coming year, but in the year following will request a much larger appropriation, which, if allowed, will permit construction of a larger unit of Esplanade than would be possible under two smaller annual appropriations.

High Pressure System Extension:

An extension of the auxiliary water supply (high pressure) system for fire protection was made on North Point Street from Powell Street to Grant Avenue, 890 feet of 10-inch pipe with necessary valves and hydrants being installed.

Another extension of the system is now under construction, a 16-inch line being laid on Leavenworth Street from Bay Street north to The Embarcadero, and 14-inch branch lines along Beach, Jones, and Jefferson Streets. A manifold for fire-boat connection will be placed on the 16-inch line at The Embarcadero.

Plans and specifications are being prepared for a 10-inch line in North Point Street between Van Ness Avenue and Larkin Street, and in Larkin Street from Bay Street to Beach Street.

These lines will give added fire protection to the waterfront and to the large factories, warehouses, and gasoline storage plants in the industrial district now being developed in this section of the City.

PROJECTS AND INVESTIGATIONS

Rincon Hill Regrade:

The Rincon Hill regrade project, though still in a preliminary stage, has progressed considerably to a point where the accomplishment of the work seems assured. Numerous hearings of property owners and interested commercial bodies were held before the Board of Supervisors, resulting in the approval by the Board of a definite plan for the financing of this project. The adopted plan was proposed through the Property Owners' Association, being an association of property owners in the Rincon Hill district, in conjunction and co-operation with the San Francisco Chamber of Commerce and this Department.

The plan submitted is as follows:

1. The property in the regrade area shall be graded to the new street level at the same time that streets are graded, and the cost of grading such property shall be borne by the holders thereof.

2. The City is to pay the cost of grading and repaving the accepted streets, as well as the cost of sewers, high-pressure systems, etc.

3. The cost of work pertaining to the unaccepted streets (not to exceed $600,000) is to be borne by an assessment district, the boundaries of which coincide with the district called for by the original plan.

4. A syndicate is to be formed, which shall acquire the property and then proceed with the regrading of the property as a whole, and its preparation as a model industrial district, primarily in the interest of the public good.

5. Accepting the values established by the appraisal of the San Francisco Real Estate Board as a basis, the owners of property on Rincon Hill shall be given the opportunity of

A. Becoming shareholders in the syndicate, receiving an interest therein equivalent to their holdings; or of

B. Selling their holdings to the syndicate; or of

C. Taking down their own property independently, but in accord with the general project.

6. The Board of Supervisors is to give these new proposals immediate consideration through the proper committee, and to proceed at the earliest possible moment to pass upon this plan, as an alternative to the plan on which the previous hearings have been held under the present resolution of intention.

Since adoption of this plan, the forming of the syndicate, as outlined, is being carried on and will be followed by the preparation of appraisals and securing of options on the property.

Sunset Tunnel:

This Department, in response to a request of the Board of Supervisors, presented on October 3, 1921, a report on the various proposed extensions to the Municipal Railway System of this City. This report thoroughly discussed the relative merits of four routes for reaching the Sunset district from the downtown section, viz., Grove Street, Laguna Honda, Eureka Valley, and Duboce Avenue routes. The following conclusion was given: "Duboce Avenue presents the most favorable opportunity for development of a permanent solution of the rapid transit problem for the Sunset District."

On May 31, 1922, the Board of Supervisors passed Resolution of Intention No. 20003, wherein they declared their intention of ordering the construction of the Duboce Avenue Tunnel. A full report, covering detailed cost estimates, plans and profile, and a plan of a tentative assessment district to pay the costs of the proposed tunnel was submitted by this office on September 18, 1922. Starting October 31, 1922, many hearings were held before the

Board of Supervisors, wherein the proponents and opponents of the plan submitted their views and protests, until on May 14, 1923, the Board adopted the following report of their Joint Committee, composed of the Finance and the Lands and Tunnel Committees:

"San Francisco, May 14, 1923.

To the Board of Supervisors,
City and County of San Francisco:

Pursuant to suggestions made in the meeting of the Board of Supervisors four weeks ago, the Finance Committee has conferred with the Lands and Tunnels Committee in the matter of the proposed Duboce tunnel.

The Finance Committee in conference with the Lands and Tunnels Committee made analysis of the reports heretofore filed by the City Engineer, and mindful of the discussions in the Board of Supervisors to provide transportation for the Sunset and Pope Tract districts, finds that this is a problem of very great importance to the City of San Francisco.

After a review of the facts heretofore produced and the reports of the City Engineer referred to, it is suggested that this proceeding in the Duboce tunnel be continued for a period of three months and in the interim the City Engineer be requested to make a full detailed estimate and report upon the plan to build the so-called Eureka Valley tunnel.

The Public Utilities Committee has repeatedly held hearings on different suggestions to provide transportation for the Sunset and Pope Tract districts and many proposals have been mentioned in the proceedings of the Board.

It appears, however, that the Board has not officially and collectively considered the feasibility of the Eureka Valley tunnel, and as this is a matter of future development of a large section of our city a delay of a few weeks would undoubtedly lead to a correct solution of the problem.

The matter is of such magnitude that every possible fact and all available information should be at hand before a decision is reached. Therefore, it is again suggested

that a continuance of three months be had which would not in effect constitute a delay in providing transportation to a district for which transportation must be established.

Respectfully submitted,

JOHN G. WETMORE,
R. McLERAN,
ANGELO J. ROSSI,
JOHN A. McGREGOR,
J. D. HYNES."

Although still adhering to the opinion that the Duboce Avenue route would provide the best rapid transit for the Sunset district, in compliance with this request of the Board of Supervisors, this Department has commenced the preparation of the desired report and is now considering various tunnel schemes for connecting the Eureka Valley with the Sunset District—schemes which embody both separate and combined vehicular and railway traffic tunnels, emerging directly on the surface of Eureka Valley, and a scheme of a railway tunnel connecting under the surface with the Twin Peaks Tunnel at Ord Street.

Golden Gate Heights:

The Trust Company handling the deeds to the properties involved in this project has received all the deeds and has practically finished the searching of titles, so that in a short time the new map of this district can be recorded and the new streets be made official. The actual change of property ownership will then be made by making deeds for the new parcels of land to the individual property owners.

Ingleside Heights:

Rapid progress in the matter of the resubdivision of Ingleside Heights has not been possible, as many of the owners of property in the affected district are non-resident, but encouraging results are shown. Seventy per cent of the owners have responded favorably to the proposed plan. Surveys and detailed plans will now be started and mean-

while the consent of the remaining property owners will be sought.

Miscellaneous Activities:

Among the activities of this Department, many of which have been more fully described in the previous annual report, may be mentioned the following:

Preparation of maps and data on the Aquatic Park and presenting same before the State Legislature, thus securing the deeding of State-owned lands to the City for enlarging the Aquatic Park;

Preparing plans and interesting property owners along Geary Street between Mason Street and Van Ness Avenue for the widening of the roadway of this street by reducing the sidewalk widths;

Collecting basic data and preparing maps for the Golden Gate Bridge project, and presenting the same at meetings of commercial bodies and county officials that are co-operating in advancing this project;

Negotiating with property owners in that portion of the Islais Creek district, known as Gift Map No. 4, for exchange of lands necessary in the rearrangement of streets, whereby this district may be developed for industrial sites;

Completion of plans and specifications for a reinforced concrete and structural steel viaduct to replace the present inadequate steel trestle over the Southern Pacific Railway right of way on San Jose Avenue at Mount Vernon Avenue. The new structure will be 710 feet in length, carrying a 60-foot roadway and 10-foot walks, with a clearance of 22 feet over the railroad tracks. Grades were established such that the intersecting thoroughfares will have connection with San Jose Avenue;

Drawing of a new official map of the City on a scale of 800 feet to the inch, which will show, in addition to other usual information, the Assessor's number for each block—previous official maps have shown only tract block

numbers, necessitating use of a special index map when referring to block books and assessment maps;

Completion of plans and preliminary data of a tentative assessment district for the extension southerly of Van Ness Avenue to Howard Street, for presentation before the Board of Supervisors;

Presenting to interested owners of property in the district bounded by Twenty-ninth and Thirty-third Avenues, Geary and Balboa Streets, plans for the grading of the property and streets in the district under new grades, and for formation of an assessment district to pay the cost of this work. This district is ideally located for residential purposes, but lacked development due to the heavy cuts and deep fills necessary to make both streets and property conform to the established grades, and which could be accomplished advantageously only by the united effort of the property owners under one contract covering the district. Due to opposition of the majority of owners to the proposed work because of the cost involved, it was decided to start public proceedings covering grading of the streets to the present official grades; leaving to each individual property owner the problem of developing his own property.

SURVEYS

Surveys Performed

Made for	1922-1923	
Public Contracts	108	
Private Contracts	260	
Resurveys for Contracts (lost points)	22	
Municipal Departments	250	
Total for Public Improvements, etc.		640
Lot Surveys—Private Owners	46	
Municipal Departments	28	
Total Lot Surveys		74
Total Surveys		714

Surveys include approximately 1455 blocks and crossings, a total length of 424,000 feet (80 miles), in addition to preliminary surveys and cross-sections for the Bay Shore Highway, Lincoln Park Boulevard, Telegraph Hill Boulevard, and other sections of the boulevard system, and the resurvey of monument lines of the district between Sixth and Sixteenth Streets, south of Brannan Street.

Precise Levels and Bench Marks

50-Vara District	338	
100-Vara District	762	
Mission	194	
Horner's Addition	41	
Sunset District	107	
Potrero and South San Francisco	564	
Western Addition	13	
Other Districts	464	
Checking U. S. C. & G.	33	
Total Bench Marks		2,516
Precise Levels—Total Miles		84.90

Maps Approved and Filed with the Recorder

Point Lobos Avenue Widening.

McLaughlin Subdivision.

San Bruno Avenue through Crocker Bay Shore Tract.

30th Avenue, Vicente Street to Wawona Street, and Wawona Street, 28th Avenue to 30th Avenue.

Evans Avenue and Marin Street Openings.

Seacliff No. 3.

Widening Intersection of Detroit Street and Circular Avenue.

Cuvier Street, Bosworth Street to Springdale Street.

Water Front Land Corporation.

Fees Received for Surveys and Inspection

1922		
July	$ 736.75	$ 1,487.25
August	1,309.50	513.00
September	665.00	1,210.50
October	432.00	1,417.50
November	857.50	2,227.50
December	590.75	2,038.50
1923		
January	1,108.50	3,115.50
February	565.50	1,280.25
March	961.50	4,183.50
April	592.00	1,518.75
May	1,200.25	1,487.25
June	550.00	1,746.00
Totals	$9,569.25	$22,225.50

STREET IMPROVEMENTS, ASSESSMENTS, ETC.

Assessments and Bonds for Street Work:

Assessments issued for cost of street work performed	63
Cost of street improvements covered by assessments	$743,331.87
Bonds prepared (in triplicate)	380
Amount of assessments guaranteed by bonds	$121,995.15
Average amount guaranteed by each bond	$ 321.04

Street Work Proceedings:

Resolutions of Intention passed	58
Street improvements recommended under Resolutions of Intention	79
Notices of street improvement posted	1,252
Notices of Resolutions of Intention mailed	2,705
Ordinances ordering performance of street improvements passed	77
Proposals of street improvements published	71
Public contracts for street improvements awarded	67
Private contracts filed	142

Notices, Permits and Investigations:

Notice to construct and repair sidewalks	1,461
Notice to construct bulkheads	518
Notice to remove obstructions	476
Notice to construct guard rails	32
Notice to reconstruct side sewers	496
Street space permits reported on	2,228
House moving permits reported on	47
Miscellaneous calls and investigations	2,387

Permits and Fees for Corporation Trenches, etc.

(In conformity with Ordinance 2201)

	Service Connections and Repairs	Mains Installed, Lineal Feet	Fees Charged
Pacific Gas & Electric Co.	4,679	93,019	$ 7,692.00
Spring Valley Water Co.	4,838	33,632	7,432.50
Great Western Power Co.	113	6,680	213.50
Pacific Telephone & Telegraph Company	234	17,534	496.50
*Miscellaneous under Special Deposits			4,144.00
Total	9,864	150,865	$19,978.50

*Permits granted for which special deposits were made to move steam shovels and tractors, to repair or install oil tanks, service pipes, fire alarm wires, cables and conduits, to lower curbs, etc.

MUNICIPAL RAILWAY

Market Street Railway Purchase:

The preliminary steps to the acquisition of the Market Street Railway system, including the valuation made by this office, were thoroughly described in the report for the fiscal year 1921-22. At the election of November 7, 1923, Charter Amendment No. 53 was adopted, permitting the City legally to acquire and operate the whole or any part of the Market Street Company's system, including the properties in San Mateo County. In December, 1922, the Committee originally formed to negotiate with the Market Street Railway Company was discharged, and a new Committee appointed by the Mayor. Following the first meeting of the new Committee, the Mayor called a meeting of prominent citizens to discuss the matter of the proposed purchase with the Committee. The concensus of opinion expressed at this meeting was that the City and the Market Street Railway Company should come to some agreement as to the details of the purchase, and the price to be paid. To date this has not been accomplished by the Mayor's Committee.

The settlement of this question is of vital importance to this City, as no permanent solution of our transportation problems can be attempted until we are in a position systematically to arrange our present street car lines and develop extensions. The advantage of a unified management of our car lines has been stressed in previous reports of this office, and needs no further amplification here.

Extensions:

During the past fiscal year many requests have been made for extensions to the Municial Railway system, involving both the construction of new trackage and the expansion of the motor bus service. In the last annual report it was pointed out that no extensions should be

undertaken which would not fit in with the unified ownership and operation of the privately owned and Municipal systems. Attention was also called to the fact that the City had no fund proper to use for the construction of extensions. These two conditions still obtain, and this office has of necessity reported unfavorably on most of the propositions presented. Many of the requests are meritorious, and the extensions desired would give needed service and assist in the development of sparsely settled portions of the City. To carry out such desired expansion, this office has suggested a bond issue of approximately two and one-half million dollars. Action on this suggestion has been deferred by the Supervisors pending the outcome of the negotiations with the Market Street Railway Company for the purchase of their system. Some of the principal extensions discussed and those on which construction has actually been undertaken are listed as follows:

Taraval Street Extension: The Taraval Street line extension from Thirty-third Avenue to the Beach, which was begun during the last fiscal year, has been completed, and cars started operating to the Ocean on January 14, 1923.

Sunset District Line: This line, which would give much needed service to the residents of the Sunset District, is involved with the construction of the Duboce Tunnel, and until that project has been decided upon, no work can be undertaken on the construction of the railway. The route was completely described in the report for the last fiscal year.

Masonic Avenue Line: This line, which would run from Masonic Avenue and Geary Street, through the Haight-Ashbury District, to Seventeenth and Stanyan Streets, was the subject of much bitter controversy during the past year. An ordinance authorizing and directing the Mayor to enter into an agreement with the Market

Street Railway Company for the use of those portions of their tracks along the route was passed by the Supervisors, but was vetoed by the Mayor and failed of repassage.

Balboa Street: The growth of the Richmond District is rapidly nearing a point where the construction of a line along Balboa Street from Thirty-third Avenue easterly will become very desirable. Though growing into a well built up and densely populated section of the district, it has, in the four long blocks between Geary and Fulton Streets, no street railway line. The population here is at the present time one-fourth of that of the entire district, and if the present rate of building is maintained, the situation may soon become acute. The proposed service would, for the present, run along Balboa Street through the Richmond District, connecting up with the Geary Street line by way of Tenth Avenue. It is possible that with the further growth of the Richmond District, the congestion on Geary Street might be such as to necessitate routing Balboa Street cars over some other street to the downtown district. A possible solution, requiring further study to avoid some steep grades, might be a continuation of the line along Balboa Street to Turk Street and thence on Turk to Market Street. This, however, is one of the problems which depends for its solution on a settlement of the Market Street Railway purchase. It is a good example of the handicap that both the Municipal and the Market Street systems are under as long as present conditions obtain.

Ocean View Line: After careful consideration of several proposed routes to serve the Ocean View District, the so-called boulevard route through the Spring Valley property was decided upon as being most practicable, and its construction was authorized by Ordinance No. 5807 of the Board of Supervisors. The line will run through the Spring Valley property approximately parallel with Junipero Serra Boulevard, thence via Worcester Street, Randolph Street, Orizaba Avenue, and Broad Street to Ply-

mouth Avenue. The sum of $265,000 has been appropriated for this construction, and work on surveys and the preparation of specifications is now under way.

The Embarcadero Bus Line: As pointed out in previous reports, a bus line along the water-front would undoubtedly be a convenience, but this office can see no way for the Municipal Railway to operate such a line except at a severe loss. Accordingly, on financial grounds alone, this office has consistently opposed the operation of such a line by the City. In view of the fact that one concern made an offer to the City to operate the buses on a rental basis, it was suggested that the difficulties might be overcome by installing the service on that system. In compliance with a resolution of the Board of Supervisors, specifications and form of contract for such services were prepared. Subsequently an ordinance was drafted authorizing the Board of Public Works to proceed, but had to be vetoed by the Mayor on account of being illegal in form.

Equipment:

The 20 center entrance street cars for the Union Street Line, which were contracted for during the last fiscal year, have been completed and are now in operation. These cars, which were described in the report of 1921-22, have displaced the old Union Street cars, which had reached the limits of their useful life.

In September, 1922, contracts were let for 20 standard cars of the type now operating on Geary Street. The car bodies, trucks, motor equipment and airbrake equipment are each covered by a separate contract. The bodies are being built by the Bethlehem Shipbuilding Corporation at their Union Plant, San Francisco, and the assembling of the completed cars is being done at this plant. The trucks are furnished by the Standard Motor Truck Company of Pittsburg, Pa., two of their type 0-55 trucks being supplied for each car. The electrical equipment is furnished by the Westinghouse Electric and Manufactur-

ing Company, each car being equipped with four of their No. 306-CV-4, 600-volt, 65-horsepower motors with type HL control and emergency device. The airbrake equipment is furnished by the Westinghouse Traction Brake Company.

The principal characteristics of these cars are as follows:

Length over bumpers	47 ft. 1 in.
Maximum width	9 ft. 2½ in.
Number of trucks	2
Number of motors	4
Horsepower of motors	65
Approximate total weight of completed car	51,000 pounds
Scheduled speed, including stops, miles per hour	11
Seating capacity, number of persons	50
Estimated cost per car	$15,250

The first of these cars has been delivered and is now being tested in actual service.

Car Barns and Shops:

The growth of the Municipal Railway has reached a point where the facilities originally provided for housing and repairing cars have become inadequate. Plans and specifications for an addition to the present Seventeenth Street car barn are being prepared. This addition will add much needed office and car storage space. Condemnation proceedings are under way for the acquisition of a block of land adjacent to and west of the Seventeenth Street car barn, to make it possible to erect a suitable car repair shop, at the same time securing a storage yard for maintenance of way materials and equipment. This location centralizes the control of the work, gives direct connection with steam road switching service, and permits of construction at minimum cost through utilization of facilities furnished by the present car barn.

Lower Market Street:

It has become necessary to replace the rails on all four tracks on Market Street from Sansome Street to the Ferry. The work is being done by the Market Street

Railway Company, the Municipal Railway paying its pro rata of the cost. The rail used is a new section, weighing 121 pounds per yard, but so designed as to fit the joint plates of the 106-pound rail, which is the standard for construction other than on Market Street. This portion of the City is on filled ground, and the streets have settled since the tracks were first constructed, making it necessary to raise the tracks in order to bring them to the official street grade. The roadway is being lifted at the same time.

Contracts:

The only contracts let during the fiscal year were those for the large street cars, the total appropriation being $336,900. A list of the contracts awarded or under way during the fiscal year is part of the current contract data included in this report.

CURRENT CONTRACT DATA, 1922 - 23.

NO.	LOCATION	CONTRACTOR	Date of Award	Date Completed	Percent Completed	Amount of Completed Contract	Amount Expended to June 30,1923	FUNDS
		BOULEVARDS, PAVING AND GRADING						
	Divisadero Street Haight Street to Clay Street	E. J. Treacy	11/19/20	5/12/22	100	$ 31,563.70	$ 14,481.97+	General Fund
	Pt. Lobos Avenue Great Highway to 48th Avenue	C. B. Eaton	9/23/21	6/22/22	100	179,749.11	169,375.35+	County Roads
	Castro Street Widening 17th Street to 19th Street	City Construction Co.	11/21/21	8/11/22	100	7,289.14	4,216.75+	General Fund
	San Jose Avenue Ottawa Street to Sicklee Ave.	Raisch Improvement Co.	12/ 5/21	7/13/22	100	56,351.16	41,414.71+	Public Assessment and County Roads
	Balboa Street 23rd Avenue to 24th Avenue	Frank J. McHugh	3/ 3/22	7/12/22	100	10,800.20	5,000.00+	Public Assessment and County Roads
	Liberty Street & Sanchez Street	Schultz Construction Co.	4/ 5/22	10/ 3/22	100	61,785.69	23,296.00+	Public Assessment and General Fund
	Great Highway, Westerly side, Cabrillo St. to Fulton Street	Pacific States Constr.Co.	5/19/22	1 /11/22	100	12,840.03	12,840.03	County Roads
	Market Street Extension, Mono Street to 24th Street	Raisch Improvement Co.	5/24/22	11/21/22	100	85,102.62	38,479.48+	Public Assessment and County Roads.
	Collingwood, 21st and 22nd Streets	C. B. Eaton	9/18/22	----	85	70,772.74	13,725.00	General Fund
	Sloat Boulevard, northerly 1/2 19th to 35th Ave.	Eaton and Smith	12/ 8/22	6/ 6/23	100	45,594.17	43,800.00	County Roads
	Lincoln Park Boulevard to 48th Ave.	Jas. R. McElroy	2/28/23	----	25	(56,614.97)	11,100.00	County Roads
	Rolph Street Extension to Mission Street	Municipal Constr.Co.	3/24/23	6/30/23	100	4,067.41	4,067.41	General Fund
	Telegraph Hill Boulevard	Louis J. Cohn	4/23/23	----	50	(23,238.00	----	County Roads
	Great Highway and Sloat Boulevard Intersection	Louis J. Cohn	6/ 1/23	----	--	(42,156.00)	----	County Roads
		SEWERS						
	Third Street Sewer Outlet Extension	Healy-Tibbitts Constr.Co.	3/ 8/22	6/ 6/23	100	5,982.70	5,982.70	General Fund
	Great Highway, Noriega St.southerly	C. B. Cowden	6/24/22	9/ 8/22	100	12,645.95	12,645.95	General Fund
	Lake St. Overflow Relief Gate	Schultz Construction Co.	6/ 5/22	7/25/22	100	212.50	212.50	General Fund
	Army Street Sewer Extension	Clinton Construction Co.	1/29/23	----	40	(115,784.50)	36,000.00	General Fund
	Bay View District Septic Tank	J. D. O'Hara	1/ 3/23	----	20	(449.00)	----	General Fund

CURRENT CONTRACT DATA, 1922 - 23.

NO.	LOCATION	CONTRACTOR	Date of Award	Date Completed	Percent Completed	Amount of Completed Contract	Amount expended to June 30,1923	FUNDS
			MUNICIPAL RAILWAYS					
125A	Street Cars, - Bodies	American Car Co.	4/ 3/22	5/10/23	100	$104,027.21	$104,027.21	Mun. Ry. Depreciation
125B	Street Cars, - Trucks	American Car Co.	4/ 3/22	11/28/22	100	27,355.00	27,355.00	Mun. Ry. Depreciation
125C	Street Cars, - Motor Equipment	Westinghouse Elec.& Mfg.Co.	4/ 3/22	11/28/22	100	50,951.11	50,951.11	Mun. Ry. Depreciation
125D	Street Cars, - Air Brake Equipment	Westinghouse Trac.Brake Co.	4/ 3/22	11/28/22	100	11,644.69	11,644.69	Mun. Ry. Depreciation
127A 127B	Steel Rails,Joints & Track Material	U.S.Steel Products Co.	1/ 6/22	10/ 4/22	100	66,051.24	66,051.24	Mun. Ry. Depreciation
129	Electric Cables and Splicing Material	Standard Underground Cable Co.	1/20/22	5/ 5/22	100	29,381.46	29,381.46	Mun. Ry. Depreciation
130	Construction of Taraval St.Line	Eaton and Smith	5/ 1/22	11/ 6/22	100	61,685.05	61,685.05	Mun. Ry. Depreciation
131	Installing Concrete Poles and Electrical Conductors,Taraval St.	Continental Constr.Co.	4/21/22	9/ 1/22	100	8,630.02	8,630.02	Mun. Ry. Depreciation
132A	Street Cars, - Bodies	Bethlehem Shipbuilding Corporation	9/ 8/22	----	80	(152,520.00)	11,439.00	Mun. Ry. Depreciation
132B	Street Cars, - Trucks	Standard Motor Truck Co.	9/13/22	1/15/23	100	31,344.40	23,604.48	Mun. Ry. Depreciation
132C	Street Cars, - Motor Equipment	Westinghouse Elec.& Mfg. Co.	9/ 8/22	----	98	(119,777.34)	92,893.93	Mun. Ry. Depreciation
132D	Street Cars, - Air Brake Equipment	Westinghouse Trac.Brake Co.	9/ 8/22	----	98	11,300.25	8,548.25	Mun. Ry. Depreciation
			MISCELLANEOUS					
	Esplanade, Section "C"	Clinton Construction Co.	8/19/21	10/11/22	100	142,854.28	142,854.28	General Fund
	Esplanade, Section "D"	Healy-Tibbitts Constr.Co.	8/23/22	5/10/23	100	52,848.13	57,252.00	General Fund
	Rock Fill along Marina Boulevard	Healy-Tibbitts Constr.Co.	1[illegible]/13/22	----	65	(42,960.00)	28,557.00	County Roads
	Street Signs - Contract #2	Louis J. Cohn	11/ 1/22	1/15/23	100	7,196.80	7,196.80	General Fund
	High Pressure Mains - North Point St.	Martin Murphy	10/13/22	12/12/22	100	2,857.00	2,857.00	General Fund
	High Pressure Mains - Leavenworth Beach,Jones and Jefferson Sts.	Hugh McOill	3/26/23	----	33	(15,771.00)	3,900.00	Special Fund by Property Owners.
	Pedestrian Walk along Great Highway	Louis J. Cohn	5/ 2/23	6/30/23	100	13,185.15	13,185.15	General Fund

Contracts amounts in parenthesis ( ) are based on estimated quantities

HETCH HETCHY WATER SUPPLY

In the early history of the struggle for the Hetch Hetchy Water Supply, it was recommended to the President of the United States, William Howard Taft, by Secretary of the Interior R. A. Ballinger, that the right to develop this water supply system, previously granted to the City and County of San Francisco under the Garfield permit, be revoked. Before any action was taken, a Board of Army Engineers was appointed to investigate and report upon all possible sources of water supply for San Francisco. Lieutenant Colonel John H. Biddle, Corps of Engineers, United States Army, was Chairman of the board appointed by President Taft.

On May 14, 1923, following an inspection trip over the project, General Biddle, now retired, addressed the Board of Supervisors of this City. The following extracts from his remarks, in which he emphatically endorses the conclusions of the advisory board, are very appropriate at this time, as they present an unbiased view of the construction activities to date:

"We went over all possible watersheds with great thoroughness, and during some two years we examined every source from the McCloud River at the north, all the way down around the sources of the San Joaquin. As the result of that investigation it was demonstrated to us absolutely, and without any possibility of doubt, that, considering the future of San Francisco and the neighboring cities of the bay region, that the Hetch Hetchy was the best and most economical, and really the only possible final source of water supply. * * *

* * * "The work at Hetch Hetchy dam is a splendid monument to your engineer, which will last, I was going to say, for a thousand years to come—maybe two thousand. The work in the tunnels is equally good, so that I am sure the people here are going to have a great deal to be proud of each day for the manner in which this great engineering project is being carried out.

* * * "I do know and want to state without reserve, that, in my opinion, Hetch Hetchy is the best if not the only really available source of water supply for San Francisco and the bay cities, and especially for those cities as they shall be in the future, and that the work that has been done is really a first-class job in every respect, and that if you shall be fortunate enough to retain the services of Engineer O'Shaughnessy the remainder of the work will be equally well done."

Progress and Developments

The Hetch Hetchy Water Supply during the fiscal year 1922-1923 has made very satisfactory progress. Work in the Mountain Division is rapidly nearing its completion, and construction has been commenced on the Bay Crossing Division in San Mateo County.

The work of the year has been directed toward the accomplishment of: First, the completion of the O'Shaughnessy Dam, the aqueduct between Early Intake and Moccasin Creek, and the Moccasin Creek Power Plant, which taken together form the first unit of the power development; second, the construction of the section of the Hetch Hetchy Aqueduct extending from Irvington to Crystal Springs Reservoir, which, in conjunction with certain work to be performed by the Spring Valley Company, will make available for use on the Peninsula the full capacity of the Company's Alameda and Calaveras sources. Under this program, in the latter part of 1924, the City will be in position to realize a large income from power sales, and will have ample water supply available to provide for its increasing needs until the aqueduct from Moccasin Creek to Irvington can be constructed at an economical rate of progress.

The O'Shaughnessy Dam has been completed and the Hetch Hetchy Reservoir behind it has been filled. Priest Dam will be completed in a few months. Work on the aqueduct tunnel between Early Intake and the head of the Moccasin Creek Penstocks is going forward with all

possible speed. The penstocks for the 80,000 kv-a. plant have been contracted for, and the power units are in transit. Work on the power house has begun, a transmission line has been surveyed and right of way for it is being purchased.

Pulgas Tunnel, at the westerly end of the aqueduct from Irvington to Crystal Springs Reservoir, is well on the way to completion, and the pipe line from Irvington to the tunnel is under contract.

The completion of the aqueduct between the Moccasin Creek Plant and Irvington will necessitate another bond issue of $32,000,000 or other financing measures. In order to preserve our water rights on the Tuolumne, funds must be provided to permit the water construction work to be prosecuted continuously till water may be delivered in San Francisco not later than 1933.

Future Power Disposal:

In view of the fact that in a comparatively short time, on completion of the Moccasin Creek Power House, the City will have available for distribution a valuable power crop, the method of disposal of this power is of vital interest at this time. The following reports on this subject have been recently made by this Department:

"April 4, 1923.

To the Honorable Members of the
Public Utilities Committee,
Board of Supervisors,
San Francisco.

Gentlemen:

In accordance with your request I have given the subject of power development on the Hetch Hetchy Project consideration and beg herewith to submit the following report on same:

The Hetch Hetchy Project, as originally planned in 1901-2 and in 1910-11, had a very moderate capacity for developing power. Under the plans devised by John R. Freeman in 1912, the plans of the aqueduct were so revised

as to provide for the development of a considerable amount of power, and on page 29, paragraph 13, he referred to power development as follows:

'The City does not propose in the immediate future to build any plant for the development of hydro-electric power, but it plans to carefully conserve all reasonable opportunities for power development against the time when it may become expedient for the City to undertake such matters, and the aqueduct will be built with surge shafts, inclined tunnels and appurtenances suitable for the attachment of turbine penstocks, and with forebays for receiving water from the tailrace of future turbines, so that substantially the only added cost for power development will be that of the power house and its foundations, the hydraulic and electrical machinery and appurtenances, and the electrical transmission lines.'

In the summer of 1913, when your City Engineer, City Clerk, and City Attorney were in Washington, pressing the consideration of the Hetch Hetchy Grant before the Congressional Committee on Public Lands, the following condition was imposed on the City for the immediate development of electric power:

'(m) That the right of said grantee in the Tuolumne water supply to develop electric power for either municipal or commercial use is to be made conditional for twenty years following the completion of any portion of the works adapted to the generation of electrical energy, as follows: The said grantee shall within three years from the date of completion of said portion of the works install, operate, and maintain apparatus capable of developing and transmitting not less than ten thousand horsepower of electric power for municipal and commercial use, said ten thousand horsepower to be actually used or offered for use; and within ten years from the completion of said portion of the works not less than twenty thousand horsepower, and within fifteen years therefrom not less than thirty thousand horsepower; and within twenty years therefrom not less than sixty thousand horsepower, unless in the judgment of the Secretary of the Interior the public interest will be satisfied with a lesser development. The said grantee shall develop and use hydroelectric power for the use of its people and shall, at prices to be fixed under the laws of California or, in the absence of such laws, at prices

approved by the Secretary of the Interior, sell or supply such power for irrigation, pumping, or other beneficial use, said prices not to be less than will return to said grantee the actual total costs of providing and supplying said power, which costs shall be computed in accordance with the currently accepted practice of public cost accounting, as shall be determined by the Secretary of the Interior, including, however, a fair proportion of cost of conduit, lands, dams, and water-supply system; and further, said grantee shall, before using any of said water for the purpose of developing hydroelectric power, file such maps, surveys, field notes, or other data as may be required by law, and shall conform to any law existing and applicable to said subject of development of said hydroelectric power for municipal or commercial uses.

'(n) That after the period of twenty years hereinbefore provided for the development, transmission, use and sale of electric power, the Secretary of the Interior, under authorization hereby given, may require the grantee, within a time fixed by the Secretary, to develop, transmit and use, or offer for sale, such additional power, and also such power less than sixty thousand horsepower as the grantee may have failed to develop, transmit, use, or sell, within the twenty years aforesaid, as in the judgment of said Secretary the grantee may or ought to develop under this grant, and which in his judgment the public interest demands or convenience requires; and in case of the failure of the grantee to carry out any such requirements of the Secretary of the Interior the latter is hereby authorized so to do, and he may, in such manner and form and upon such terms and conditions as he may determine, provide for the development, transmission, use, and sale of such additional power and such power not so developed, transmitted, or used by the grantee at the end of said twenty years up to sixty thousand horsepower; and for that purpose the Secretary of the Interior may take possession of and lease to such person or persons as he may designate such portion of the rights of way, structures, dams, conduits, and other property acquired or constructed by the grantee hereunder as may be necessary for the development, transmission, use, and sale of such power.'

The Irrigation Districts of Turlock and Modesto were granted the right to use power from the Hetch Hetchy

Project at cost. Since that time they have built the Don Pedro Dam and have a surplus of power available, so that no consideration can be given to them as a customer at the present time.

In the City Engineer's Annual Report of 1914-15 reference was made to a hydroelectric power study made at my request by a board of engineers comprising W. F. Durand, J. G. Galloway, and F. G. Baum.

A general arrangement of the hydroelectric plant has been based on the findings of this Board, which recommended the omission of the surge chamber on the westerly portal of the aqueduct, and moving the same about half a mile southerly from the recommendations made in the Freeman plan. This report also recommended the construction of a large forebay reservoir 145 feet in depth and 1,325 feet above the power house floor. Certain other recommendations made by this body of engineers, such as the reducing of the size of the tunnel to one-half the present capacity, were, on the advice of the City Attorney, disregarded.

Program: At the present time the construction program includes the building of a power house at Moccasin Creek, having installed therein a capacity of 50,000 kv-a. with an ultimate capacity of 120,000 kv-a. This program also includes the installation of tunnels, penstocks and pressure pipe necessary to bring the water from the Hetch Hetchy Dam to the above-mentioned power house, and the installation of transformers, switches, and transmission line for the purpose of transmitting the power generated to a switch house at Newark and continuing thence to San Francisco.

Progress of Work: On this basis the work has proceeded to the following extent: The tunnels from Intake diversion dam to the Priest Reservoir will be completed in about 12 months. The Intake diversion dam will be completed in nine months. The Priest Reservoir is 80 per cent completed and the Moccasin Creek power tunnel 50 per cent. The camp buildings and shops for the purpose of building the power house are virtually completed and the steel has been ordered for the power house building. The hydraulic and electric machinery are 75 per cent completed and will soon be ready for shipment, and the order has been placed for the electrical conductors for the transmission line.

With the completion of the Hetch Hetchy Dam and the diversion of water from Lake Eleanor there will be sufficient water available even in dry years to operate a plant at Moccasin Creek of 52,500 kilowatts continuously at 100 per cent load factor. This would amount to 460,000,000 k.w.h. per year; or at 65 per cent load factor would be equal to 300,000,000 k.w.h. per year.

Cost of Power: For the purpose of determining the rate to be charged for power I have taken a plant valuation of $18,000,000, divided as follows:

Power house	$7,000,000
Aqueduct	5,000,000
Hetch Hetchy Dam	3,000,000
Transmission Line	3,000,000

These figures include all of the necessary machinery and equipment to deliver power into San Francisco.

On the basis of this valuation, the operating and fixed charges would appear as follows:

Interest on $18,000,000	$ 990,000
Depreciation on plant and equipment	264,292
Insurance on power house	70,000
Maintenance cost of power plant and equipment	88,367
Operating costs	221,500
Making a total operating charge per year of	$1,634,159
Adding 5 per cent for overhead	81,707
Bond redemption to the amount of 1/40th per year of the total investment, or	450,000
Makes a grand total of operating and fixed charges	$2,165,866
We could reasonably expect a profit of 10 per cent on this cost, which would be equal to	216,586
Adding this to the operating and fixed charges would give a total of	$2,382,452

which is the desired gross revenue to be obtained on a sale of 300 million k.w.h. per year generated at the Moccasin Creek power house.

Three hundred million k.w.h. per year delivered in San Francisco, allowing for line losses of 10 per cent, would amount to 270,000,000 k.w.h. per year, and in order to pay the profit of 10 per cent before mentioned, it will be necessary to charge 8.824 mills per k.w.h. delivered at San Francisco.

For comparison I would call your attention to the following table of current purchased by the Pacific Gas & Electric Company during the year 1921:

	K.W.H.	Amount	Av. per K.W.H. Mills
Cal. Ore. P. Co.	57,385,000	$ 208,543	3.64
Gt. Western P. Co.	66,701,878	512,854	7.7
S. J. Lt. & P. Co.	63,548,025	429,416	6.76
Snow Mt.	15,738,974	79,015	5.
Hetch Hetchy	8,427,000	46,558	5.55
Melones Mg. Co.	3,711,333	31,897	8.6
Utica Mg. Co.	4,189,191	32,435	7.7
Coast Co. Gas Co.	34,078	445	13.1
West Side Lbr. Co.	963,000	6,523	6.75
S. J. R. R. Pen. Ry. Co.	279,994	3,393	12.1
Pac. Port. Cement	4,564	45	10.
	220,983,037	$1,351,129	

	Peak K.W.	Peak During		Delivery
Cal. Ore. P. Co.	12,500	April	At Delta	60 K.V.
Gt. Western P. Co.	22,200	June	Oakland	To Trans. 60 K.V. To Dist. 11 K.V.
S. J. Lt. & P. Co.	15,500	Dec.	Newman	60 K.V.
Snow Mt.	5,840	Feb.	Santa Rosa	60 K. V

Regarding the above table of current purchased it must be remembered that the prices for power are at wholesale rates and the point of delivery is a governing factor on account of the increased cost of transmission, maintenance, operation and capital invested.

Distribution Cost: If the City is to distribute the power itself, it will have to build the transmission line into San Francisco, construct the necessary sub-stations, and either buy or duplicate much of the present distributing facilities in San Francisco, including the necessary standby steam generating stations, in order to give service to the people. I have not prepared or, within the time allotted by your Committee, had time to prepare an estimate of the cost of building such a distributing and standby system. Mr. Randall Ellis, Valuation Engineer for the City, has, however, compiled for me from the Railroad Commission's valuation of the distributing system of the Pacific Gas & Electric Company the valuation placed by the Commission on that portion of the system which would meet the City's needs for distributing and standby service in San Francisco, and finds that the valuation of that por-

tion of the system is $20,900,000, new, or $16,800,000 depreciated to condition as of December 31, 1919. This is based on historical reproduction, with average costs taken for a five-year period ending December 31, 1919.

If the City were to build a duplicate system today, present-day prices would, of course, have to be taken into consideration. On the other hand, it is probable that certain economies could be effected through the construction of a system which is based on present-day needs instead of having been built up piecemeal, as was the system of the Pacific Gas & Electric Company. I do not know just what those economies would mean in dollars and cents, but for the purpose of this report I assume that they probably would be equal to the depreciation which the City would be entitled to deduct from the reproduction valuation of the Pacific Gas & Electric Company's system in order to arrive at its fair present value. It is, therefore, probably not far from correct to assume that the cost of building a complete distributing system with the necessary steam standby service in San Francisco would not be less than seventeen million dollars. In this connection, it is necessary to contemplate the inconvenience to the City and its citizens from having practically every street torn up for the laying of the distributing lines and connecting services.

The second alternative under municipal distribution would be, of course, to buy the existing system of the Pacific Gas & Electric Company. This could be done through agreement or through exercise of the right of eminent domain, as was done by the City of Los Angeles in connection with the Edison system in that city. If this alternative is followed, however, it is, of course, possible, and I may say probable, that the Railroad Commission would require the payment of a considerable sum as severance damage on account of taking away from the Pacific Gas & Electric Company one of its principal markets for electricity. In the case of the City of Los Angeles, the severance damage which the city was required to pay by the Commission was the sum of $2,453,000.

It is obvious that another bond issue would have to be authorized for the construction or purchase of such a distributing system and that the existing bond debt limit of the City would have to be raised in order to permit this bond issue.

As an initial undertaking by the City it might be desirable to take over the sub-station supplying the Municipal Railways with power, as well as the street lighting, averaging 40,000,000 k.w.h. yearly, at an annual cost of $800,000. The cost of sub-station plants and distributing systems should not exceed $1,350,000. This will leave 260,000,000 k.w.h. available for market purposes from a sub-station near Newark.

Consumers: The latest complete data available on the power sold in San Francisco is to be had from the annual reports of the various power companies to the Railroad Commission for the year 1921. This shows power sold in San Francisco as follows:

	K.W.H.
Great Western Power Co.	62,099,000
Universal Electric & Gas Co.	30,104,991
Sierra & San Francisco Power Co.	139,056,564
Pacific Gas & Electric Co.	146,148,047
Total	377,408,602

This power was distributed among approximately 123,357 consumers and its segregated uses are as follows:

	K.W.H.	K.W.H.
Municipal street lights	6,566,041	
Miscellaneous municipal lighting	150,773	
Municipal power	103,000	6,819,814
Municipal Railway	30,194,720	
Other railways	138,256,058	168,450,778
Commercial lighting	102,972,468	
Commercial power	97,906,071	
Other power	1,259,471	202,138,010
Grand total		377,408,602

For municipal use alone:

	K.W.H.	K.W.H.
Street lights	6,566,041	
Miscellaneous lighting	150,773	
Power	103,000	
Municipal Railways	30,194,720	
Total, per year		37,014,534

The foregoing outline of procedure shows that there are several serious impediments to be overcome before the

City could actually own and operate its own power distributing system. On the other hand, if the people desire to do so, there is no doubt but that they can be overcome and that with the distribution system owned by the City we might anticipate profitable returns in future years. I believe, however, that before intelligent decision can be made as to whether the City should immediately embark upon the construction or acquisition of this distributing system some examination should be made of the other alternative. It is probable that initially one of the existing power companies might agree to buy the entire power output of the Moccasin Creek plant, delivering to the City such portion thereof as is required for the operation of the Municipal Railways, lighting the streets and public buildings, and paying a reasonable price for the balance.

From the foregoing table it will be noted that the total amount for municipal use alone is 37,014,534 k.w.h. per year, for which the City is now paying rates ranging from 11.5 mills to 2¾ cents.

The question as to whether the City should undertake the distribution of the hydroelectric power from Hetch Hetchy itself, or should sell the same at wholesale to some public service corporation, or should enter into an agreement with some public service corporation under which the latter, acting as the agent of the City, should distribute the power, is a question of policy which requires consideration of several factors to enable the correct decision to be made.

The present plans, as I have stated, call for the transmission of the power from the Moccasin Creek plant to a switching station near Newark.

Whatever arrangement is considered can only be determined through negotiation between the City of San Francisco and the power companies. It is entirely a question for your decision as to whether they should be undertaken, and, if so, who should represent the City in the conduct thereof. In handling contracts for purchase of power for operating the Municipal Railways negotiations for same have been made so far by the Board of Public Works. From casual statements made to me by power company officials, I believe that they would be glad to discuss the matter with your duly authorized representatives at any time.

There are, of course, legal questions connected with this problem of distribution through power companies, but, so far as I am advised, they are not insurmountable. The main thing today is to first decide the question as to what is the best policy for the City to follow from the standpoint of obtaining immediate profits from our Hetch Hetchy venture and looking to the ultimate full public ownership of all means of utilizing the same, in accordance with the declared policy of our municipal charter. If it should prove impossible to obtain satisfactory terms through negotiations with the power companies, it may be necessary for us to undertake the solution of the entire problem of distribution through municipal channels. If satisfactory terms can be obtained it may prove the better policy to make temporary arrangements for distribution of the power through privately owned channels and devote our finances and construction forces to the completion of the water supply end of the project. The people of San Francisco must not forget that the Hetch Hetchy project is primarily a water supply project; that in order to preserve our valuable water rights on the Tuolumne River it will be necessary to put them to use with reasonable dispatch and continuously construct works designed to that end. It will not do for us to turn the water loose at the tailrace of the Moccasin Creek power plant and expect it always to remain available for the future use of the City for domestic purposes. If San Francisco would preserve these water rights for the use of the City it must continue the construction program on the aqueduct necessary to bring the water here. This in turn will involve an additional bond issue of approximately thirty million dollars. I believe that this factor should be considered by your Board in determining whether or not it is wise to embark on the power distribution business first, or to temporarily entrust that to other hands while we are completing the Hetch Hetchy aqueduct to San Francisco.

Recommendation: Before complying with your request to make a definite recommendation as to the policy which the City should follow, I recommend that we learn what terms the power companies will agree to if it should be decided to market our electric energy through them, and whether or not the Railroad Commission will acquiesce in making an agreement on such terms. It is not necessary to say that this does not mean that the City must accept

those terms. If one or more of the companies will not agree to a fair proposition which it will be profitable for the City to consider, I shall recommend its rejection. I believe, however, it would be desirable to know what they are willing to do before attempting to decide this problem with which we are now confronted.

Respectfully submitted,

M. M. O'SHAUGHNESSY,
City Engineer."

"City and County of San Francisco,
Department of Public Works,
Bureau of Engineering,

September 11, 1923.

To the Honorable the Mayor and the Board of Supervisors, City and County of San Francisco, San Francisco, California.

Gentlemen:

I transmit herewith a report on the subject of the disposal of the Moccasin Creek power output, as requested under Resolution No. 21398 (New Series), adopted by your Board on July 30, and signed by the Mayor August 7, 1923.

In the report I have reviewed briefly some historical facts relative to the Hetch Hetchy project which bear directly on this question, and have pointed out some of the obligations to which the City authorities are committed, both by legal requirement and by vote of the people, in the matter of completion of the water supply for the citizens of San Francisco and for the preservation of our valuable water rights.

I am recommending that condemnation proceedings be instituted for the acquisition of the existing distributing systems of both the Great Western Power Company and the Pacific Gas & Electric Company, and suggesting that pending securing of possession of the properties, a temporary arrangement be made for the disposal of the power.

In this way a municipal distribution system can be obtained at the earliest moment, and a revenue of $2,000,-

000 be had by the City each year during the period of litigation.

Your respectfully,

M. M. O'SHAUGHNESSY,
City Engineer."

"City and County of San Francisco,
Department of Public Works,
Bureau of Engineering,

September 11, 1923.

To the Honorable Mayor and Board of Supervisors:

Under date of April 4, 1923, I submitted to the Public Utilities Committee a report on the Moccasin Creek power development with reference to the generating and distributing costs. At the time I had been requested by that committee to recommend a policy for the disposal of the power ouptut from that plant. In the conclusion of that report I stated:

'Before complying with your request to make a definite recommendation as to the policy which the City should follow, I recommend that we learn what terms the power companies will agree to if it should be decided to market our electric energy through them, and whether or not the Railroad Commission will acquiesce in making an agreement on such terms. It is not necessary to say that this does not mean that the City must accept those terms. If one or more of the companies will not agree to a fair proposition which it will be profitable for the City to consider, I shall recommend its rejection. I believe, however, it would be desirable to know what they are willing to do before attempting to decide the problem with which we are now confronted.'

After a number of meetings on this question and much discussion of the same, the chairman of the Public Utilities Committee introduced a resolution which was adopted by your Board on July 30, and signed by the Mayor August 7, 1923, requesting the City Engineer to ascertain from the several power companies and report to your Board at the earliest moment:

(1) The terms under which the total output in electric energy from the Hetch Hetchy project could be

marketed through the agency of either or both of said corporations for a period not exceeding ten years from and after the same shall be available for distribution.

(2) The price at which each of said corporations would be willing to sell to the City and County of San Francisco such portions of its distribution system in said City and County as may, in the opinion of the City Engineer, be adapted to the distribution by the City of such electric energy, including the necessary plants for furnishing steam stand-by service.

(3) The period of time for which each of said corporations would be willing to grant an option to the City and County to purchase said distribution system and stand-by plant, at said prices.

(4) Whether or not either of said corporations would be willing to sell their local distributing systems and stand-by plants to the City and County on a pay-as-you-go plan, and if so, on what terms.

And your Board further requested that this office furnish your Board with an itemized estimate of the cost of building a complete distribution and stand-by system for the marketing and distributing of said electric energy independently of existing plants.

Acting under the authority of this resolution, I called upon Mr. Mortimer Fleishhacker, representing the Great Western Power Company, and upon Mr. W. E. Creed, president of the Pacific Gas & Electric Company, and requested that each submit a statement responsive to the four specific requests set forth in the resolution. Copies of the statements received are appended hereto.

In response to your further request, I have made an estimate of the cost of building a complete distribution and stand-by system for the marketing and distribution of the Moccasin Creek power independently of the existing systems. This estimate is incorporated in this report.

Review of Power Question. Historical:

Before taking up the propositions submitted by the power companies, and the consideration of the estimate of an independent distributing system, I feel that it is proper that I should place before your Board in some detail a

review of the entire power question as it affects the citizens of San Francisco.

On January 4, 1910, the people of San Francisco, by a vote of 32,886 for and 1,609 against, a ratio of over 20 to 1, authorized a bond issue of $45,000,000 for the

> 'acquisition, construction and completion of a public utility, to-wit: a water supply works to be owned and controlled by the City and County of San Francisco, to furnish said City and County of San Francisco, and to the inhabitants thereof, a sufficient supply of water for all purposes, the sources of such supply to be Lake Eleanor, the waters of the Tuolumne River, and its tributaries, in Tuolumne County, California.'

This bond issue was voted under the so-called Garfield permit of May, 1908. Under this permit and the plans and estimates prepared in conformance therewith, it was contemplated that only a relatively small amount of power would be developed and transmitted, primarily for use in pumping the water developed from the Hetch Hetchy system over the Coast Range Mountains near Altamont, with possibly some small amount for municipal use only in San Francisco. The Garfield permit prohibited the sale of power to private persons or to corporations in San Francisco, requiring that the surplus be sold to the irrigationists at cost.

It cannot be said, therefore, that the people, in voting the water bonds of 1910, had any idea of going into municipal distribution of power in San Francisco, as it was expressly prohibited by the Garfield permit.

Following the bond election, a new Secretary of the Interior, Mr. Ballinger, served notice on San Francisco to show cause why the Hetch Hetchy portion of the Garfield permit should not be revoked. After more than two years' fight on our part, Congress, in September, 1913, passed the Raker bill, which materially modified a number of conditions imposed upon the Garfield permit. Under this grant we are required to develop hydro-electric power, not less than 10,000 horsepower initially, and increasing by fixed increments up to 60,000 horsepower within twenty years, such electricity to be used or offered for municipal and commercial purposes, after satisfying the power demands of the Modesto and Turlock irrigation districts at cost.

This provision of the act was a governing factor in determining the location and size of the aqueduct in the mountain division, for you will appreciate that it was necessary to drive these tunnels to the full size in the first place in order to provide for the ultimate water and power development requiring 620 cubic feet of water per second, or 400,000,000 gallons daily, and that this tunnel aqueduct must be located so as to be able to utilize the full pressure drop for power purposes. This requirement increased very materially the initial cost of the aqueduct over and above that necessary if designed and constructed for water supply purposes only.

I would also call to your attention a fact which the public should bear in mind, and that is that while these water supply bonds were voted in 1910 on the basis of plans and estimates made in 1908, the Raker bill was not passed until the latter part of 1913, so that it was really not until 1914 that work was actually commenced.

After that progress has been made as rapidly as the limited funds derived from the sale of bonds permitted. The war starting in 1914 interfered with the sale of bonds and also with the progress of the work, causing the costs of labor and material to greatly increase, so that even today the cost of construction work is nearly double what it was in 1910, when the bonds were voted.

These conditions very early made it apparent that the project could not be completed within the original 1908 estimate of $45,000,000, which was based on a small initial development along different lines. A careful study of the situation led me to the conclusion that the mountain division of the project, including the Moccasin Creek power plant, should be completed as a unit. The installation of the power house generating units and transmission lines at an inconsiderable additional expense offered prospects of a revenue from power at an early date sufficient to carry the interest on the cost of the entire mountain development, thus facilitating financing the completion of the aqueduct to San Francisco. The wisdom of this step has never been questioned.

On three different occasions charter amendments have been submitted to the electorate of the City of San Francisco with a view to excluding public utility or water supply bonds from the 15 per cent debt limit. Each time these

measures failed, the first time, November 5, 1918, by a vote of 43,999 against to 23,525 for; the second time, November 2, 1920, the measure failed by a vote of 66,970 against to 55,681 for; the last time, November 7, 1922, the proposition lost, 59,410 No to 37,061 Yes.

The adoption of any of these measures would have cleared the way for the completion of the water supply project and for the acquisition or construction of a municipal distribution system for our power.

Present Power Development:

We are today constructing a hydro-electric plant at Moccasin Creek which will have an initially installed capacity of 70,000 kilowatts, in four units of 17,500 kilowatts each. Provision is being made for the later installation of two additional units, making the ultimately installed capacity of this plant 105,00 kilowatts. Power from Moccasin Creek power house will be transmitted at 154,000 volts from Moccasin Creek to San Francisco. From the plant to the lower end of the bay a double circuit, single-tower transmission line is to be constructed, and from the bay to San Francisco a single circuit copper line. These transmission lines will have a capacity to deliver the full output of the Moccasin Creek power plant to the distribution center. The right of way now being purchased for the transmission line is of sufficient width to provide for a second line of towers, carrying two other circuits, which will take care of the total ultimate power development from the Tuolumne sources.

The Hetch Hetchy water project will develop and render available, both for water supply and power purposes, 400,000,000 gallons daily, or 620 cubic feet per second. This amount of water is sufficient to operate only three of the units at Moccasin Creek power house to full capacity continuously, and produce at the power house a maximum of 460,000,000 kilowatt hours annually, at 100 per cent load factor. The fourth unit of the initial installation, and the two future units, will be used to handle the peak loads in connection with the delivery of power both from Moccasin Creek and the future plants at Early Intake and North Mountain.

Our present program of construction contemplates the completion of the Moccasin Creek plant and the transmission line in the latter part of 1924.

Prospective Power Developments:

In addition to the power development at Moccasin Creek there are two other prospective power developments in connection with the Hetch Hetchy project, described in my annual report of 1920, page 79, namely, the Early Intake Plant No. 3, 42,000 kilowatts, and the North Mountain Plant No. 4, 26,000 kilowatts. These, in addition to the ultimate development at Moccasin Creek, represent a future possible total installed capacity of 173,000 kilowatts, equivalent to more than 230,000 horsepower.

Table No. 1, following, sets forth the present and future possible development of the Hetch Hetchy project. The information contained in this table is of particular interest in view of the power market in San Francisco.

TABLE NO. 1.

Estimated Power Development Hetch Hetchy Water Supply.

	Present Moccasin Creek	Ultimate Moccasin Creek	With 21,000 K.W. at Early Intake	With 42,000 K.W. at Early Intake	With 26,000 K.W. at North Mountain
Total capacity, kilowatts	70,000	105,000	126,000	147,000	173,000
Maximum possible annual output (millions of kilowatt hours)	460	460	644	828	1,056
Output at 65% load factor (millions of kilowatt hours)	400	460	644	828	985
Delivery at bay end of transmission line, 65% load factor (millions of kilowatt hours)	360	414	580	745	887
Output at 50% load factor (millions of kilowatt hours)	306	460	552	644	758
Delivery to sub-station, 50% load factor (millions of kilowatt hours)	275	414	497	580	682
Delivery to consumers, 50% load factor (millions of kilowatt hours)	214	322	386	450	530

San Francisco Power Market—Present and Future:

The latest information obtainable on the power consumption in San Francisco indicates that during the year 1922 there was used in San Francisco for light and power purposes as actually metered to consumers a total of over 409½ million kilowatt hours. To provide this electricity there was delivered to the substations in San Francisco 516 million kilowatt hours. This would indicate a loss in transformation and distribution of 106½ million kilowatt hours, or 20.6 per cent of the power delivered to substations. The proportion of this power distributed by the several companies is shown in Table No. 2.

TABLE NO. 2.

Distribution in San Francisco by Power Companies, 1922.

Utility	Input to Substations K.W.H.	Distribution at Meters K.W.H.
Pacific Gas & Electric Co.	229,714,011	158,668,336
Sierra & San Francisco Power Co.	200,368,175	147,301,400
Great Western Power Co.	85,976,461	71,787,762
Universal Electric & Gas Co.	(Included with Sierra)	31,770,832
Total	516,058,647	409,528,330

A study of the available data covering the past ten-year period indicates that the consumption of power in San Francisco has doubled in that time, which is equal to an average increase of 8 per cent each year. This rate and even higher rates have been used by others to estimate the future requirements of San Francisco. On this basis, in the next ten years, or by 1933, it would be necessary to deliver to the substations in excess of one billion kilowatt hours for the year.

Based on what I consider a very conservative probable rate of growth of the city's population, and a likewise conservative rate of increase in per capita consumption of power, I have placed the rate of increase in demand for electrical energy in San Francisco at 5 per cent per annum. Table No. 3 shows the future growth of San Francisco and the corresponding power requirements, as estimated on the above basis:

TABLE NO. 3.

Estimated Future Growth and Demand for Power.

Year	Estimated Population	Estimated Demand (Deliveries to Consumers) K.W.H.	Required output of Generating Plant K.W.H.
1925	561,000	474,000,000	676,000,000
1926	573,000	498,000,000	710,000,000
1927	584,000	523,000,000	746,000,000
1928	596,000	549,000,000	785,000,000
1929	608,000	576,000,000	822,000,000
1930	620,000	605,000,000	864,000,000
1931	632,000	635,000,000	906,000,000
1932	645,000	667,000,000	954,000,000
1933	658,000	700,000,000	1,000,000,000
1934	671,000	735,000,000	1,050,000,000
1935	684,000	772,000,000	1,100,000,000
1940	755,000	986,000,000.	1,410,000,000
1941	771,000	1,035,000,000	1,480,000,000
1942	786,000	1,087,000,000	1,550,000,000
1943	802,000	1,141,000,000	1,630,000,000
1944	818,000	1,198,000,000	1,710,000,000
1945	834,000	1,258,000,000	1,790,000,000

Reference to Tables 1 and 3 indicates that the present proposed Moccasin Creek power plant is only capable of caring for about 45 per cent of the 1925 requirements for San Francisco, and that even with the installation of two additional units at Moccasin Creek, we would still be short at the power house 216 million kilowatt hours necessary to meet the demand. On the assumption of complete municipal distribution, this means that the deficiency would have to be made up by power from other sources, preferably from a steam stand-by station.

Extension and Development Requirements:

Assuming an adequate distributing system for San Francisco in 1925, and our Moccasin Creek power plant supplemented by the necessary stand-by plant or other source of power, it is apparent that provision must be made for taking care of San Francisco's growth. A very conservative estimate indicates that it will be necessary each year thereafter to put into the distributing system alone in San Francisco at least two million dollars to take care of the extensions necessitated by the increase in electric power consumption. To provide this additional power, it will require immediate commencement and prosecution of our Early Intake and North Mountain power developments

in the mountains at a rate requiring a further expenditure of between three and four million dollars annually, or a total additional of 18 million dollars by 1928, at which time it will have been necessary to complete the total possible Hetch Hetchy power development. These additional sums of money cannot come from the revenues derived from the sale of power except in small part, so must largely come from further bond issues.

I am citing these facts not with the idea of magnifying the difficulties of the problem, but of placing squarely before you a full knowledge of the responsibilities which San Francisco must assume in entering into complete municipal distribution of power, which is, I believe, the only way in which we should go into this field.

The charter provides that the City shall gradually acquire and ultimately own all of its public utilities. This mandate applies with equal force to its street railways, its water supply and its power. We have made good progress in the acquisition and development of our railways. We have undertaken the construction of our water supply under authority and by vote of the people. It will require some 32 millions of dollars additional to complete the Hetch Hetchy Water Project to deliver water to San Francisco. It will require approximately 38 million dollars to acquire the Spring Valley properties.

Water Supply:

I must again emphasize the statement made in my report of April 4th, that:

> 'In order to preserve our valuable water rights on the Tuolumne River, it will be necessary to put them to use with reasonable dispatch, and continuously construct works designed to that end. It will not do for us to turn the water loose at the tail-race of the Moccasin Creek power plant and expect it always to remain available for the future use of the City for domestic purposes. If San Francisco would preserve these rights for the use of the City, it must continue the construction program on the aqueduct necessary to bring the water here.'

Our water supply conditions in San Francisco are crying for immediate relief, as indicated by the vote on the original bond issue of 1910. Water is retailed in San Francisco at an average price of about 29 cents per thousand

gallons, the highest price in any large city in the United States. By spending $32,000,000 additional between Moccasin Creek and Irvington for the completion of the Hetch Hetchy project this situation would be corrected, and every well-informed visitor who has examined the project has agreed to the propriety of spending this money to complete this project. Our water conditions in San Francisco demand immediate and pressing attention. The collapse in 1906 of existing facilities caused almost fatal damage to our City. The completion of the 73 miles of auxiliary high-pressure system is a security against property damage to the region served and saves policyholders $1,000,000 yearly in insurance premiums. It will be necessary to build large storage reservoirs at high levels, three at least of 300 million gallons capacity each—one at Amazon Street, one at Dog Park Tract at Ocean Avenue, and one at San Miguel—to safeguard a proper water supply for our people. On my initiative, and with thanks to the co-operation of your Public Utilities Committee, in March of last year we undertook, with the approval of your Board, the construction of the $5,000,000 aqueduct, 22 miles long, from Irvington to Pulgas Tunnel, near Crystal Springs Reservoir, which we expect to complete in December, 1924. This safeguards the adequacy of the peninsular supply of the Spring Valley Water Company for a period of ten years. Before the expiration of this period the main aqueduct between Moccasin Creek and Irvington should be completed.

The foregoing cost estimates of future power development, the completion of the main Hetch Hetchy aqueduct and the construction of adequate service reservoirs inside the City limits are very essential elements to be borne in mind in a discussion of our present financial ability to undertake a program of immediate municipal distribution of power.

Whenever the City goes into the power distribution business it must be with full recognition of the obligations connected therewith. It must be prepared to take care of the future growth in power demand, and it must concurrently undertake the completion of its water supply system as outlined in other portions of this report, thus assuring protection of its basic water rights on the Tuolumne River and an adequate supply of pure mountain water at reasonable rates for our people for all time.

Power Companies' Proposals:

Having brought out the foregoing elements bearing on the situation in general, I turn now to the specific points covered in your resolution and take them in order:

(1) The statements received from the Great Western Power Company and the Pacific Gas & Electric Company indicate their willingness to act as the City's agents in marketing the electrical energy from the Hetch Hetchy project at such a figure as will return to the City of San Francisco from $2,000,000 to $2,150,000 yearly, or over 5 per cent on $40,000,000 capital investment.

(2) Neither the Great Western Power Company nor the Pacific Gas & Electric Company are in a position to state, nor can they determine within a reasonable time, a valuation for sale of such portions of their distributing systems within the City and County as would be adapted for the City's use in distributing its own energy. Neither company states whether it would be willing to sell if that price were known.

(3) Not being able to name a price for their distributing system, neither company is in a position to grant an option.

(4) Neither the Great Western Power Company nor the Pacific Gas & Electric Company are willing to sell their local distributing systems and stand-by plants to the City on a pay-as-you-go plan, it being apparent from the statement previously made in this report that it is not possible to take care of the necessary extensions of service and increase in power development from the revenue alone, to say nothing of paying off the capital cost of the property.

Independent Distribution and Stand-by System:

Following is an estimate of the cost of building a complete distributing and stand-by system for the marketing and distributing of the electrical energy from the Moccasin Creek power plant, independent of the existing plants. Notwithstanding the limited time available for making the study and estimate, the matter has been quite thoroughly gone into, and by development of standards and comparisons with costs of similar construction at present-day prices I have arrived at a total cost of such a system, amounting in round numbers to $45,000,000, itemized as follows:

Step-down substation at end of transmission line reducing the transmission voltage to a lower voltage, and cables and conduits for transmitting this lower voltage through the City of San Francisco	$ 3,500,000
Distribution substations, conduits, cables, services, meters, poles, wire	30,500,000
Steam stand-by station	6,000,000
Street lighting equipments	4,500,000
Miscellaneous equipment and headquarters	500,000
Total	$45,000,000

This estimate appears high in comparison with the historical valuation placed on the distributing system of the Pacific Gas & Electric Company and the Great Western Power Company by the Railroad Commission. This is in part accounted for by the fact that the proportion of the proposed system to be placed underground is much higher, in that I have anticipated the underground requirements for the next ten years. In other words, no overhead has been figured where this would have to go underground within ten years. Also, there is included underground circuits for street lighting to replace the gas now used in about half of the streets of San Francisco.

You will appreciate that a complete independent system for the distribution of all of our power at once involves more or less hypothetical assumptions, although I have actually tentatively laid out such a system. We cannot conceive of actually constructing a complete system such as the estimate was based on as an initial installation, for the very practical reason that there would not be a market to receive all of the power. The market could only be built up slowly if in competition with existing companies; this would take a number of years. The total estimate is of value, however, for the purposes of comparison with existing systems and in establishing the cost of a part of a future development, which the City would need to anticipate and prepare for should it undertake the construction of an independent municipal power distribution system.

In the plan on which the estimate is based, I have considered the installation of underground cables and conduits for the transmission of the energy from the receiving step-down station to the various sub-stations, the general scheme providing a complete ring of circuits connecting all of the sub-stations, and with additional circuits connecting opposite points of the ring. The Great Western Power Company and the Pacific Gas & Electric Company at the present time

maintain 16 stations in San Francisco from which power is distributed. This estimate is based on an initial installation of but 10 stations, providing, however, for an ultimate of 18. The estimate is further based on using underground construction in all present underground districts and, in addition, as before mentioned, I have anticipated the underground requirements for the next ten years.

For your further information, I might add that I have given some consideration to the initial outlay necessary to install the necessary receiving step-down stations, the underground transmission to the various sub-stations, and the distribution system necessary to take care of our own municipal requirements, and a certain additional load that might be immediately picked up. In other words, what might be considered the necessary foundation for a distributing system designed to enter a competitive field such as would eventually be developed to correspond to that covered in the estimate, and have placed the cost of this at approximately 15 million dollars. Such initial development would naturally be intended to enter the downtown business and industrial centers, without serving the residential districts. Should your Board declare a policy for the construction of an independent system, the bond issue should be sufficient to provide for the complete system in order that extensions could be made and new business taken on as rapidly as could be obtained.

Recommendations:

As between the construction of an independent distributing system and the acquisition of the existing distributing systems, there can be, I believe, no argument in favor of constructing an independent system in a competitive field, as against the acquisition of the existing systems, with their developed markets. An independent system should only be considered as a last resort in the event that the existing systems could not be acquired, either by negotiation or condemnation proceedings within a reasonable period of time, during which our power plants was not producing revenue.

Under the charter we are committed to the ultimate ownership of our public utilities. There is no question in my mind, nor, I believe, in the minds of any of your Board, but that San Francisco should eventually own and operate her own distributing system for her own electric power. Further, there is no question that whatever figure the power

companies might name for the disposal of their existing distributing systems, it would be necessary for independent valuations to be made of these properties. The Railroad Commission of the State of California is best qualified to make such valuation, and the public generally would have the greatest confidence in the fairness of a valuation made by this Board. Therefore, as a step which will minimize the delay in whatever plan your Board may adopt, I would recommend that your Board take the necessary action and immediately instruct the City Attorney to bring suit in eminent domain for the acquisition of the entire portions of the distributing systems of both the Pacific Gas & Electric Company and the Great Western Power Company, necessary for serving all of San Francisco.

Under this procedure the Railroad Commission will make a valuation of these properties. A suit should then be filed in the Superior Court setting up this valuation and asking for a decree in condemnation entitling the City to take possession of the properties upon payment of this price. When such a decree has been obtained an election should be held to vote the bonds necessary to acquire the properties. The bonds should be sold and the price tendered or paid into the court.

It is my opinion that if San Francisco distribute the output of the Moccasin Creek power plant directly to the consumers we should take over the entire distribution within the City and purchase temporarily such additional power as may be needed in order that all districts may share in whatever benefits may be derived. This would also avoid complications of division of ownership and authority in any parts of the existing systems which otherwise might be required for common use between private companies and the City. This condition would of necessity exist on account of the different districts being inter-connected for service from the distributing center.

Should your Board institute condemnation proceedings for these properties it would, of course, be impossible for any one to state with any degree of authority the length of time necessary to acquire possession of the same. The time required would depend largely on the attitude of the power companies in either facilitating or attempting to delay proceedings. I understand that it took Los Angeles over five years to effect possession; in Marin County it took between two and three years to acquire the existing water system.

Notwithstanding the efforts of the City Attorney to hasten the pending gas rate litigation involving valuation of gas properties in San Francisco, over six years have been consumed in trial and appeal. Should it appear that possession of the distributing systems cannot be obtained for some considerable period after completion of the Moccasin Creek plant, I would recommend, pending securing such possession, that your Board arrange for the marketing of the power either through the agency of the existing companies in San Francisco or in any other possible way which can be arranged.

Any such arrangement should terminate automatically upon securing possession of the properties and should be so drawn as to conform with all legal requirements.

Failure to provide for such temporary disposal of the Moccasin Creek power output when the plant is ready for operation will, on the basis of the offers made by the power companies, subject the taxpayers of San Francisco to an annual loss of not less than $2,000,000.

Respectfully,

M. M. O'SHAUGHNESSY,
City Engineer."

Organization and Headquarters Work

The work is under the general direction of M. M. O'Shaughnessy, City Engineer. Nelson A. Eckart, Chief Assistant Engineer, continues in charge of the project, having supervision, under the general direction of the City Engineer, over all the Hetch Hetchy work.

City Headquarters Office:

The City Office staff designs and prepares plans and specifications for new work to be undertaken, prepares detail plans for work already in progress in the field, selects and purchases equipment for work being done by day labor under "cost plus fee" contracts, and handles all bills and payrolls. Important items of this work carried out during the past year are: Design of Early Intake diversion works, design of Moccasin Creek power plant and penstocks, design of Red Mountain Bar siphon, design

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA.

CONTRACT NO. 90 PROPOSITIONS A AND B.

For the construction of the BAY CROSSING PIPE LINE in the Bay Crossing Division of the Hetch Hetchy Aqueduct

RECORD OF BIDS RECEIVED

Bids received May 16, 1923.
Contract awarded May 18, 1923 to
Western Pipe & Steel Company.

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
	Bidder's Name and Address	Bidder's Name and Address	Bidder's Name and Address	Bidder's Name and Address	Bidder's Name and Address	Bidder's Name and Address
	Moore Dredge Co. 809 Balfour Bldg. San Francisco. Total bid on entire contract Prop.A. $2,003,099.10 Prop.B. $3,225,396.60	Western Pipe & Steel Co. of Cal. 444 Market St. San Francisco. Total bid on entire contract Prop.A $2,021,589.00 Prop.B. $2,221,461.25	R.G.Shaffer & Co. 804 Crocker Bldg. San Francisco. Total bid on entire contract Prop.A $1,998,280.00 Prop.B. $3,326,305.00	R.G.Shaffer & Co. 804 Crocker Bldg. San Francisco. Total bid on entire contract Prop.A $2,007,910.00 Prop.B. $3,258,135.00	Babbitcher Shipbuilding Corp.,Ltd. San Francisco. Total bid on entire contract Prop.A. $2,441,215.10 Prop.B.	

Item No.	ITEM	Quantity Estimated	Unit	Unit Price Bid	Total Bid	Unit Price Bid	Total Bid	Unit Price Bid	Total Bid	Unit Price Bid	Total Bid	Unit Price Bid	Total Bid	Unit Price Bid	Total Bid
1.	Items B.1.F. and I.			6.00 per ton Steel Pipe		6.00 per ton Steel Pipe		Item B.1.F. Steel Pipe		Item B.1.F. Steel Pipe		6.00 per ton Steel Pipe			
1a.	Pipe of 7/16" plate, Howard Sec., not including pipe on trestle & bridge	21,742	lbs.fl.	25	543 55	24	521 808	24	521 808	24	521 808	21	456 822		
2.	Pipe of 7/16" plate, Bowers Sec., on trestle and bridge.	17,555	lbs.fl.	29	509 09	24	421 320	24	421 320	24	421 320	21	368 655		
3.	Pipe of 7/16" plate, Redwood Sec., not including pipe on trestle & bridge.	33,100	lbs.fl.	29	959 90	24	794 400	24	794 400	24	794 400	21	695 100		
4.	Pipe of 7/16" plate, Redwood Sec., on trestle and bridge.	6,700	lbs.fl.	29	194 30	24	160 800	24	160 800	24	160 800	21	140 700		
5.	Pipe of 3/8" plate, Redwood Sec.	1,203	lbs.fl.	28	50	24	28 872	24	28 872	24	28 872	21	25 263		
6.	Pipe of 5/16" plate, Redwood Sec.	12,170	lbs.fl.	29	353 30	24	292 080	24	292 080	24	292 080	21	255 570		
1-6	TOTAL FOR PIPE ITEMS	102,740	lbs.		3,081 324		2,465 392		2,465 392		2,465 392		2,156 343		
7.	Expansion joints for pipe of 5/16" plate	5	joints	400 00	1,000 00	549	2,745 00		2,400 00		2,500 00		2,500 00		
8.	Expansion joints for pipe of 3/8" and 7/16" plate	30	joints	424 00	12,720 00	98	2,940 00		2,400 00		2,500 00		2,500 00		
9.	Manholes	55	manholes	197 00	10,835 00	94	5,170 00		4,675 00		4,675 00		4,675 00		
10.	Reinforcing plates, bumped heads, and other special steel	8,000	pounds		.12		.08		.08		.08		.08		
11.	Installing castings furnished by City	15,000	pounds		.03		450 00		2,400 00		4,800 00		4,800 00		
12.	Laying cast iron pipe furnished by City	10,000	pounds		.03		300 00		300 00		1,200 00		1,200 00		
13.	Installing metal work furnished by City, not included in Items 11 and 12	30,000	pounds		.08		2,400 00		2,400 00		6,000 00		6,000 00		
1-13	TOTAL FOR SECTION A														
14.	Earth excavation, Moore Section (CY pipe)	63,000 (pipe) 42,000	cu.yds. (earth)	.83											
15.	Rock excavation, Howard Section	52	cu.yds.	6 83		4									
16.	Earth excavation, Redwood Section (CY pipe)	33,000 (pipe) 22,000	cu.yds. (earth)	.83											
17.	Rock excavation, Redwood Section	400	cu.yds.	6 83	2,732 00	4	1,600 00		1,600 00		1,600 00		1,600 00		
18.	Dry rubble masonry	300	cu.yds.	5 83	1,749 00	5	1,500 00		1,800 00		1,800 00		1,800 00		
19.	Concrete, Class A	650	cu.yds.	38 82	25,225 00	30	19,500 00		19,500 00		19,500 00		19,500 00		
20.	Concrete, Class B	50	cu.yds.	55 00	2,750 00	62	3,100 00		3,100 00		3,100 00		3,100 00		
21.	Extra Work	25	lbs.	3 00	75 00	3	75 00		75 00		75 00		75 00		
22.	Pot Toroid g steel	8,000	pounds	.12	960 00	.12	960 00		960 00		960 00		960 00		
23.	Firebrick roof in drums	250	cu.yds.	5 00	1,250 00	5	1,250 00		1,250 00		1,250 00		1,250 00		
24.	Six inch underdrains	1,000	lin.ft.	.75	750 00	.60	600 00		750 00		750 00		750 00		
25.	Broken rock pavement	2,000	sq. ft.	.22	1,320 00	.15	300 00		300 00		300 00		300 00		
26.	Asphaltic surface on broken rock pavement	1,000	sq. ft.	.33	330 00	.15	150 00		150 00		150 00		150 00		
1-26	TOTAL FOR SECTION B				3,225,396 60		2,221,461 25		3,326,305 00		3,258,135 00		2,441,215 10		
	Amount of certified check				375,000 00		250,000 00		350,000 00						
											Bid rejected as Prop. B failed to comply with Sec. 45 page 40 Instructions to Bidders.		Bid rejected as Prop. B failed to comply with Sec. 45 page 40 Instructions to Bidders.		

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA.

CONTRACT NO. 91

	PROPOSITION G Furnishing and delivering:					
1.	Steel pipe (welded)	9 150 000	Pounds	2 65	882	975 00
2.	Cast steel anchor rings	370 000	Pounds	15	55	500 00
3.	Erection or expansion joints		Pounds	35	73	955 00
4.	Manholes		Pounds	35	4	095 00
					1016	525 00
	PROPOSITION H Furnishing, delivering & installing:					
1.	Steel pipe (welded)	9 150 000	Pounds	11 5	1088	850 00
2.	Cast steel anchor rings	370 000	Pounds	17 25	63	825 00
3.	Erection or expansion joints		Pounds	37 25	78	709 25
4.	Manholes		Pounds	37 25	4	358 25
5.	Installing metal work furn. by City	342 000	Pounds	5	17	100 00
					1252	842 50
	REMAINING PROPOSITIONS, J TO M, APPEAR ON SHEET 2.					

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA.

CONTRACT NO. 91

Furnishing and Delivering — STEEL PENSTOCKS AND ACCESSORIES for the Moccasin Creek Power Plant. — Sheet 1 of 2.

RECORD OF BIDS RECEIVED

Contracts awarded on May 25, 1923, as follows:
Proposition A to Western Pipe & Steel Co. of California for $213,714.70
Proposition B to U. V. Erlicson for $1,316,525.90

Item No.	ITEM	Quantity Furnishing	Quantity Delivering	Units	No. 1 Bidder's Name and Address: V. S. Erlic, 76 New Montgomery Street, San Francisco	No. 2 Bidder's Name and Address: Western Pipe & Steel Company, 444 Market St., San Francisco	No. 3 Bidder's Name and Address: Pacific Coast Aggregate Corp., Pacific Bldg., San Francisco	No. 4 Bidder's Name and Address: Bethlehem Ships Building Corp., Ltd., 25th & Illinois Sts., San Francisco	No. 5 Bidder's Name and Address: R. G. Wallace Company, 90 West St., New York City	No. 6 Bidder's Name and Address: Moore Drydock Co., Oakland, Calif.
					Total bid on entire contract: See note below. Sheet 2	Total bid on entire contract: $1,325,556.32	Total bid on entire contract: $1,284,847.25 Prop. A - $213,714.70 Prop. B - $1,071,132.55	Total bid on entire contract: $1,316,525.90 Prop. A - $213,714.70 Prop. B - $1,102,811.20	Total bid on entire contract: Prop. A - $257,949.96	
	SECTION 1 - STEEL PORTION									
	PROPOSITION A Furnishing and delivering									
1.	Steel pipe (various)	3,798,000		Pounds						
2.	Cast steel anchor rings	30,000		Pounds						
3.	Erection or expansion joints			Pounds						
4.	Manholes			Pounds						
	PROPOSITION B Furnishing, delivering & installing									
1.	Steel pipe									
2.	Cast steel anchor rings									
3.	Erection or expansion joints									
4.	Manholes									
5.	Incidental metal work for [illegible]									
	PROPOSITION A Furnishing and delivering									
1.	Steel pipe			Pounds						
2.	Cast steel anchor rings			Pounds						
3.	Erection or expansion joints			Pounds						
4.	Manholes			Pounds						
	PROPOSITION B Furnishing, delivering & installing									
1.	Steel pipe									
2.	Cast steel anchor rings									
3.	Erection or expansion joints									
4.	Manholes									
5.	Incidental metal work for [illegible]									
	PROPOSITION A Furnishing and delivering									
1.	Steel pipe									
2.	Cast steel anchor rings									
3.	Erection or expansion joints									
4.	Manholes									
5.	Incidental metal work for [illegible]									
	PROPOSITION B Furnishing, delivering & installing									
1.	Steel pipe (various)									
2.	Cast steel anchor rings	370,000		Pounds						
3.	Erection or expansion joints									
4.	Manholes			Pounds						
5.	Incidental metal work for [illegible]	34,000								
	REMAINING PROPOSITIONS, 2 TO 8, AS PER SHEET NO. 2.									

C 968 - 51 - 1

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

CONTRACT NO. 91

Furnishing and delivering STEEL PENSTOCKS AND ACCESSORIES for the Moccasin Creek Power Plant.

RECORD OF BIDS RECEIVED

Item No.	ITEM	QUANTITY ESTIMATED	Unit	No. 1 Bidder's Name and Address: E. T. Ryan 4 Van Nessmercy Street San Francisco. Total bid or entire contract: See note below.		No. 2 Bidder's Name and Address: Western Pipe & Steel Company, 444 Market St. San Francisco. Total bid or entire contract: Prop. A - $1,010,670. Prop. J - $1,447,744.40.		No. 3 Bidders Name and Address: Puget Sound Machinery Depot Seattle, Wash. San Francisco. Total bid or entire contract: $1,325,556.22.		No. 4 Bidder's Name and Address: Bethlehem Shipbuilding Co. Ltd. 16th & Illinois St. San Francisco. Total bid or entire contract: Prop. A - $878,343.25 Prop. J - $1,5[illegible]39.2[illegible]		No. 5 Bidders Name and Address: W. P. Kellogg Company, 90 West St. New York City. Total bid or entire contract: Prop. A - $1,[illegible]25.00 Prop. J - $1,329,124.25.		No. 6 Bidders Name and Address: Moore Drydock Co. Balfour Bldg. San Francisco. Total bid or entire contract: Prop. A - [illegible] Prop. J - $257,949.86.	
				Unit Price Bid	Total	Unit Price Bid	Total	Unit Price Bid	Total	Unit Price Bid	Total	Unit Price Bid	Total	Unit Price Bid	Total	Unit Price Bid	Total
	SECTIONS I AND II COMBINED																
	PROPOSITION J																
	Furnishing and Delivering:																
1.	Steel pipe (riveted)	17,736	Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
2.	Cast steel anchor rings	[illegible]	Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
3.	Erection or expansion joints		Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
4.	Manholes		Each			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
	PROPOSITION K																
	Furnishing, delivering & installing																
1.	Steel pipe (riveted)	[illegible]	Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
2.	Cast steel anchor rings	[illegible]	Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
3.	Erection or expansion joints		Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
4.	Manholes		Each			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
5.	Installing metal work furnished by City		Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
	PROPOSITION L																
	Furnishing and delivering																
1.	Steel pipe (welded)	[illegible]	Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
2.	Cast steel anchor rings	[illegible]	Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
3.	Erection or expansion joints		Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
4.	Manholes		Each			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
5.	Installing metal work furnished by City		Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
	PROPOSITION M																
	Furnishing, delivering & installing																
1.	Steel pipe (welded)	[illegible]	Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
2.	Cast steel anchor rings	[illegible]	Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
3.	Erection or expansion joints		Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
4.	Manholes		Each			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
5.	Installing metal work furnished by City		Pounds			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
	Amount of certified check			[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
				[illegible]													

C 98 91-2

of and preparations of specifications for Bay Crossing pipe line, and design of a steel bridge to carry the latter line over a portion of Dumbarton Strait.

The headquarters staff includes: R. P. McIntosh, Leslie W. Stocker and R. J. Wood, Civil Engineers; P. J. Ost, Electrical Engineer; E. P. Jones, Mechanical Engineer; H. W. Kephart, Purchasing Agent; and a staff of assistant engineers, draftsmen and other employees.

Specifications for Contract 90 were issued in April, 1923. This contract covers the construction of 19.5 miles of steel pipe line, from a point near Irvington, Alameda County, to the east portal of Pulgas Tunnel, three miles west of Redwood City. The pipe line is designed to have a capacity of 45 million gallons daily when in use as a part of the Hetch Hetchy gravity aqueduct. The specifications permit the use of 60-inch riveted, 58-inch welded, or 58-inch lock-bar pipe. Bids were solicited for furnishing and laying any of the three classes of pipe in the section east of San Francisco Bay, or that west of the Bay, or in both, and either with or without trench excavation. Bids were opened on May 16. Three regular bids were received, all bidders offering proposals for the entire work. The lowest bidder was the Western Pipe and Steel Company, and the contract for a 60-inch riveted steel pipe line was awarded to that company on May 18, at an estimated price of $2,231,661.25. A schedule of bids, prices and quantities on Contract 90 appears inserted between pages 80 and 81.

Specifications for Contract 91, for furnishing and delivering steel penstocks and accessories for the Moccasin Creek Power Plant, were also issued in April, 1923. The specifications call for penstocks to supply water to the four 25,000 H. P. waterwheel units which are to be installed in 1924. Designs were prepared for riveted pipe and for welded pipe. Bids were solicited on both classes of pipe, either for manufacturing or for manufacturing and installing, and for the upper and lower portions separately or together. Six bids were received and opened

on May 23. The contract for furnishing and delivering the upper portion was awarded to the Western Pipe and Steel Company of California for the estimated price of $213,016.70. That for furnishing and delivering the lower portion was awarded to M. W. Kellogg Company for $1,016,525.00. The City elected to install the penstocks with its own forces. A schedule of bids, prices and quantities for this contract is given on tables inserted between pages 80 and 81.

Specifications for Contract 93 are in preparation, and will be issued during July. This contract will cover the construction of steel bridge spans to carry the Hetch Hetchy Aqueduct pipe lines across the shallower part of Dumbarton Strait. There will be 36 bridge spans, each 105 feet long, 21 feet wide, and 15 feet high, built to accommodate an ultimate installation of two 6-foot 4-inch steel pipes. The bridge will contain about 2,880,000 pounds of steel. The contract will also include wooden pipe sills and walkways, but will not include the main concrete piers to support the bridge structure. These piers will be built under another contract.

A list of the important features of all the Hetch Hetchy Water Supply contracts prepared during the past year appears in the appendix. This list is continuous with sheets printed in the report for 1921 and 1922.

Descriptions of several hundred parcels of land required for rights of way for the aqueduct and transmission lines were prepared and turned over to the right-of-way agent for purchasing.

Field Headquarters:

On the work in the Sierra Nevada, the two division organization instituted in February, 1921, has been continued up to the present. Field headquarters for aqueduct construction, power plant construction, and railroad operation have been at Groveland, in charge of L. T. McAfee, Construction Engineer. Headquarters for operations at

O'Shaughnessy Dam, Hetch Hetchy Reservoir, Lake Eleanor and Mather Sawmill, were at Damsite, in charge of C. R. Rankin, Construction Engineer. The completion of the dam and its appurtenances has now rendered unnecessary the maintenance of the upper division as a separate unit, and the remaining work in the Sierra Nevada will be administered from Groveland. Field headquarters for the Bay Development, which includes the Bay Crossing and Peninsular Divisions, will be located at Redwood City, where C. R. Rankin will be in charge.

Employees in the Field:

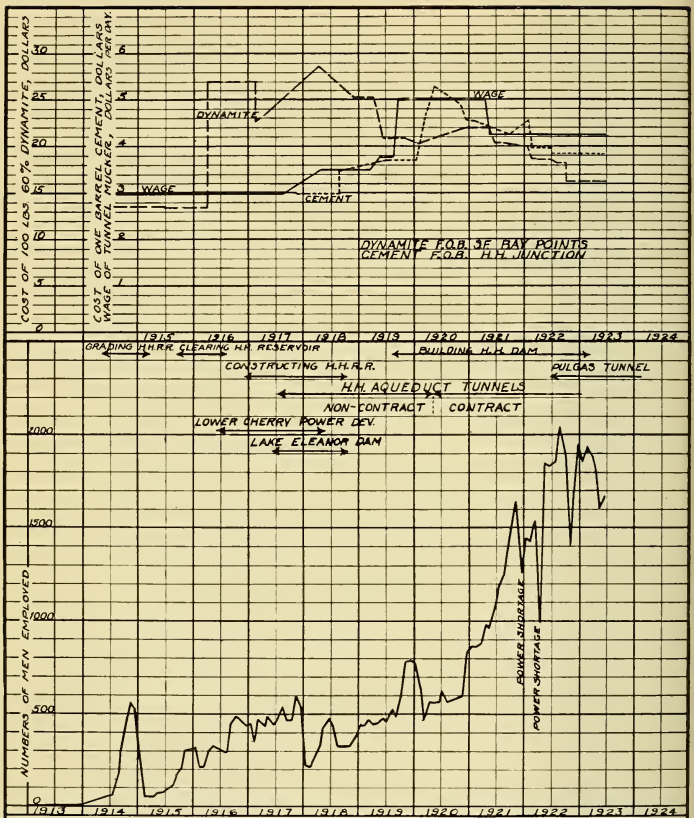
The number of employees in the field varied from about 1,400 to 2,050, the average number being about 1,850. The number and distribution on a typical day in June, 1923, were as follows:

Hetch Hetchy Dam	74
Priest Dam and Reservoir	117
Mountain Division Tunnels	525
Moccasin Creek Power Plant	363
Railroad	274
Red Mountain Bar Siphon	39
General and Miscellaneous	175
Pulgas Tunnel	109
Total	1,676

These figures include both direct employees of the City and those employed on Hetch Hetchy work by the various contractors, but do not include employees in the San Francisco office.

Groveland Headquarters:

A few additions were made to the personnel of the Groveland headquarters staff, due to the increase of the working force caused by the opening up of construction on Moccasin Creek power house and tunnels, penstock excavation, Red Mountain Bar siphon and the Early Intake diversion dam. No changes were made in the housing facilities at Groveland.



HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

UPPER: GRAPHIC RECORDS OF COSTS OF LABOR AND MATERIALS
LOWER: GRAPHIC RECORD OF NUMBER OF MEN EMPLOYED

NOTE: EMPLOYEES IN THE SAN FRANCISCO OFFICES ARE NOT INCLUDED IN THE COUNT

DEPARTMENT OF PUBLIC WORKS. APPROVED ..... CITY ENGINEER

BY H. O. S. ... TRACED H. O. S. .. CHECKED .....

SCALE ..... DATE JUNE 30, 1923.

A 165

Hospital: At 4 A. M. on July 27, 1922, a fire originating from the oil burner of the kitchen range totally destroyed the hospital building and contents. It was with difficulty that the twenty or more patients were removed to safety.

The occupants of the City's clubhouse were moved and this building turned over to the hospital staff. Surgical instruments were rushed from Sonora and San Francisco and in a few days the staff was able to handle all cases.

Work was started at once on a new building located on the old site and rushed to completion. The new hospital was fully equipped and turned over to the Doctor on October 1, 1922. It is a single story building with basement, 50 by 128 feet in size, and has a capacity of 75 patients.

Cases treated at the hospital during the past fiscal year were as follows:

Non-hospital cases	872
Hospital cases:	
City's direct employees	188
Construction Co. of North America (Tunnel contractor)	260
Utah Construction Co. (O'Shaughnessy Dam contract)	8
Outside pay patients	109
Total hospital cases	565
Total cases treated	1,437
Capital operations	163
Average time in hospital for hospital cases	15.1 days

Groveland Water Supply: The City's headquarters, shops, etc., and the town of Groveland continued to be supplied with water from the Second Garrote shaft and tunnel.

When the shaft reached tunnel grade, the sump at the 460-foot level, from which the clear water had been pumped for the water supply, became dry, and it was necessary to use water from the bottom of the shaft. To remove any chance of contamination, a chlorination outfit was installed and the chlorine put into the pump suction.

Groveland Sewer System: The outfall sewer, 1,150 feet of 8-inch iron-stone pipe, constructed by the City across its property in the Spring of 1922, was extended by the townspeople and all side sewer connections made. As a result the sanitary conditions of the town are greatly improved.

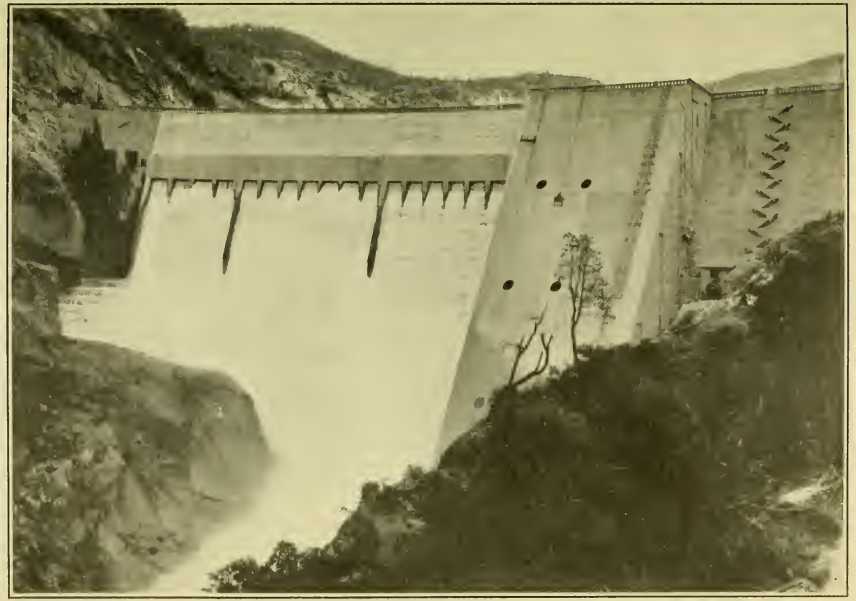
O'Shaughnessy Dam.

O'Shaughnessy Dam has been completed during the past fiscal year. It has a crest height of 226.5 feet above the original streambed level and a height of 341 feet above the lowest point in the foundation. This present crest is at elevation 3,726.5 feet above sea level, and the foundation is constructed of sufficient dimensions to permit extending the dam an additional 85.5 feet in height, or to elevation 3,812 feet.

The Utah Construction Company, under Contract No. 61, has been continuously engaged since September, 1919, upon the construction of this dam. During the year 1919, only preparatory work was performed, including the erection of camp buildings, a small sawmill, tramway, narrow-gauge tracks, compressor plant, shops and work upon the diversion tunnel and diversion dam. During the year 1920, the diversion dam upstream from the main structure, the diversion tunnel for by-passing the stream flow and the backwater dam were completed.

The upstream diversion dam, as described in previous reports, consisted of a rock-filled timber crib resting on the sand and gravel river bed, with a plank sheathing on the upstream face and with sheet piling extending down through the sand and gravel to a stratum of cemented gravel.

The back-water dam, opposite and above the lower end of the by-pass tunnel, consisted of a thin concrete wall which was carried down to a boulder formation twenty-two feet below the river bed and grout then pumped into the gravel. The top of the dam was carried to elevation 3,520 or about twenty feet above the river bed.



O'SHAUGHNESSY DAM, HETCH HETCHY WATER SUPPLY PROJECT.
Downstream face with siphon spillway in action.

The diversion tunnel is 23 feet by 25 feet, 900 feet in length and in solid granite formation.

During 1920 a 15-ton cableway with 300 H. P. electric motor, and a rock crushing and screening plant were installed. Stripping of the side walls of the canyon and the excavation of the cut-off trench were carried on throughout the year. Due to the narrowness of the gorge, this work while in progress prevented any excavation below streambed.

From January to August, 1921, excavation of the foundation from river bed to bedrock, and of the cut-off trench in the solid rock was carried on. This involved the removal of 81,500 cubic yards of material consisting of sand, gravel, boulders, and granite. The work was carried on with a Marion No. 36 steam shovel, loading into 4-yard side dump cars, which were hauled up an incline track by 18-ton saddle-tank locomotives. Below elevation 3,435 the material was shoveled by hand into skips and transferred by derrick to side dump cars operating on a high bench track at elevation 3,540.

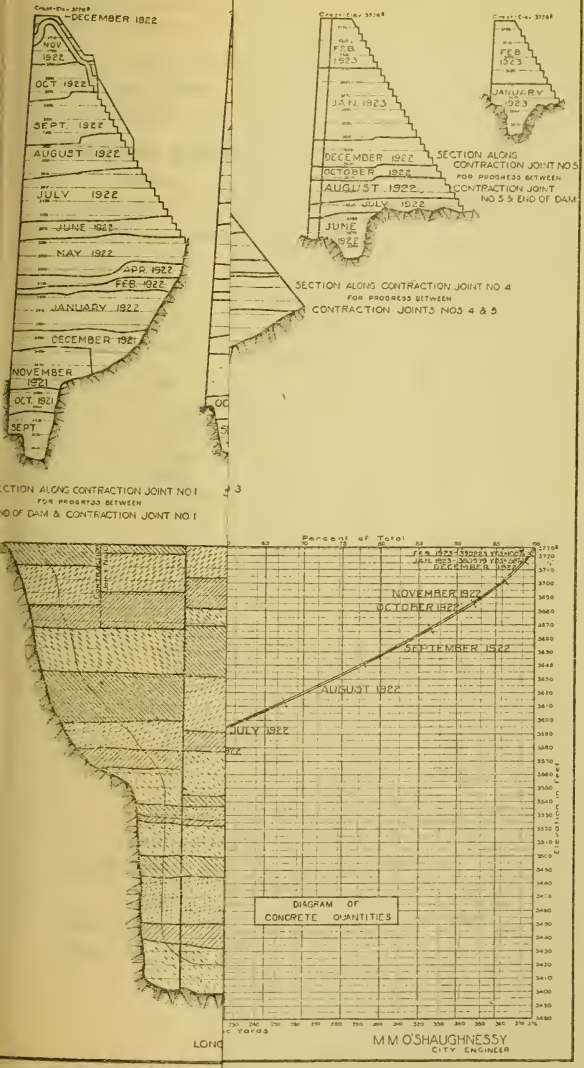
The lowest point of the natural bedrock, a point in a pothole near the central portion of the structure, is at elevation 3,386 or 114 feet below original streambed. The lowest point in the foundation is at elevation 3,382 or 118 feet below streambed and 344 feet below the crest of the dam.

A shaft 20 by 26 feet, which permits ladder wells to be carried to the valve operating chambers in the diversion tunnel, was sunk and completed October 31, 1921.

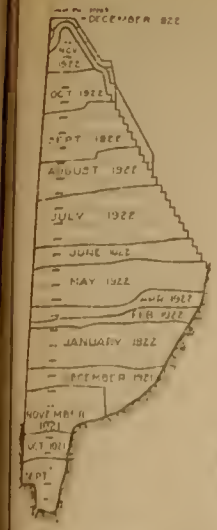
The bedrock foundation was prepared for a good bond by removing a layer of rock or by using a sand blast and removing all scale, scum and glaze and leaving a clean rock surface.

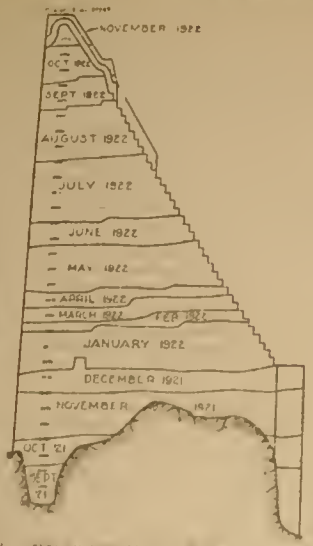
Concrete Below Streambed:

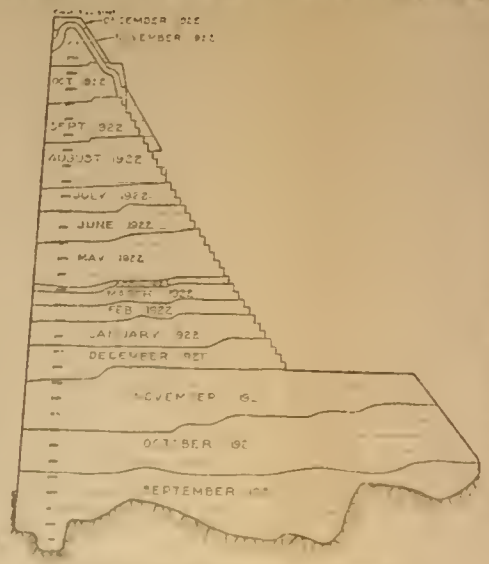
Concrete pouring was started in September, 1921, in the lowest portions of the foundation pit and carried on

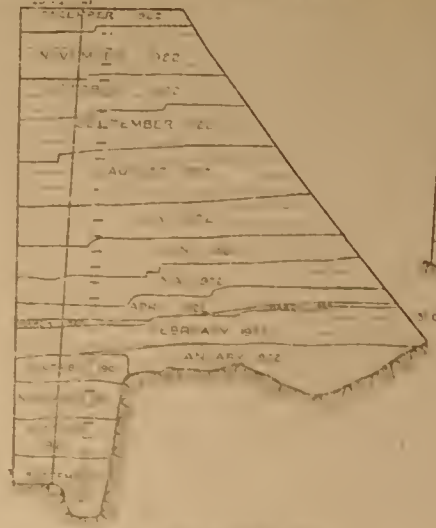

DECEMBER 1922
NOV. 1922
OCT. 1922
SEPT. 1922
AUGUST 1922
JULY 1922
JUNE 1922
MAY 1922
APR. 1922
FEB. 1922
JANUARY 1922
DECEMBER 1921
NOVEMBER 1921
OCT. 1921
SEPT.
FEB. 1923
JAN. 1923
DECEMBER 1922
OCTOBER 1922
AUGUST 1922
JULY 1922
JUNE 1922
JANUARY 1923
SECTION ALONG CONTRACTION JOINT NO 5
FOR PROGRESS BETWEEN
CONTRACTION JOINT NO 5 END OF DAM
SECTION ALONG CONTRACTION JOINT NO 4
FOR PROGRESS BETWEEN
CONTRACTION JOINTS NOS 4 & 5
CTION ALONG CONTRACTION JOINT NO 1
FOR PROGRESS BETWEEN
ND OF DAM & CONTRACTION JOINT NO 1
Percent of Total
NOVEMBER 1922
OCTOBER 1922
SEPTEMBER 1922
AUGUST 1922
JULY 1922
DIAGRAM OF
CONCRETE QUANTITIES
c Yards
LONG
M M O'SHAUGHNESSY
CITY ENGINEER

HETCH HETCHY DAM
PROGRESS CHART OF CONCRETE PLACING

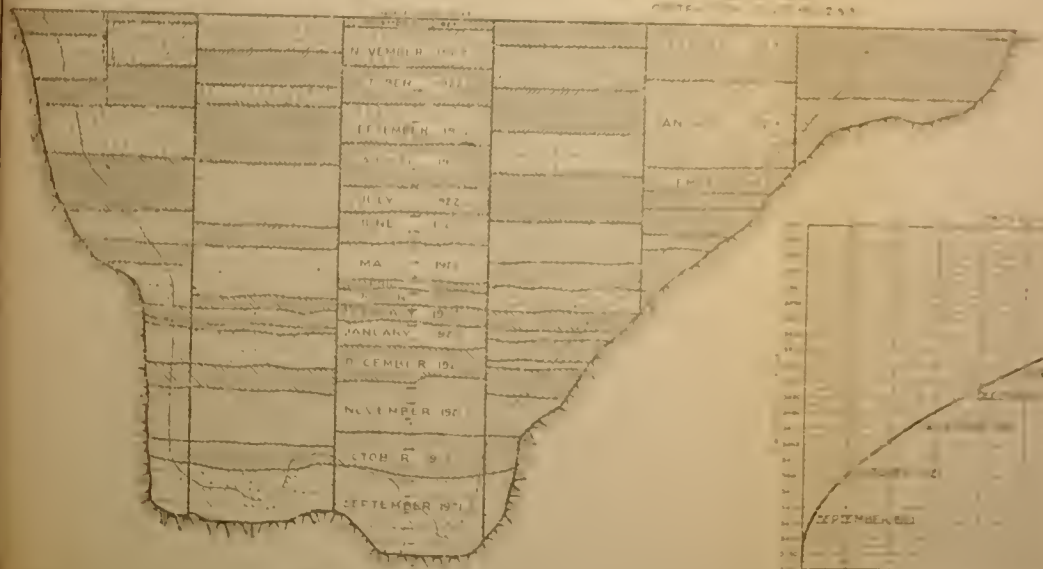




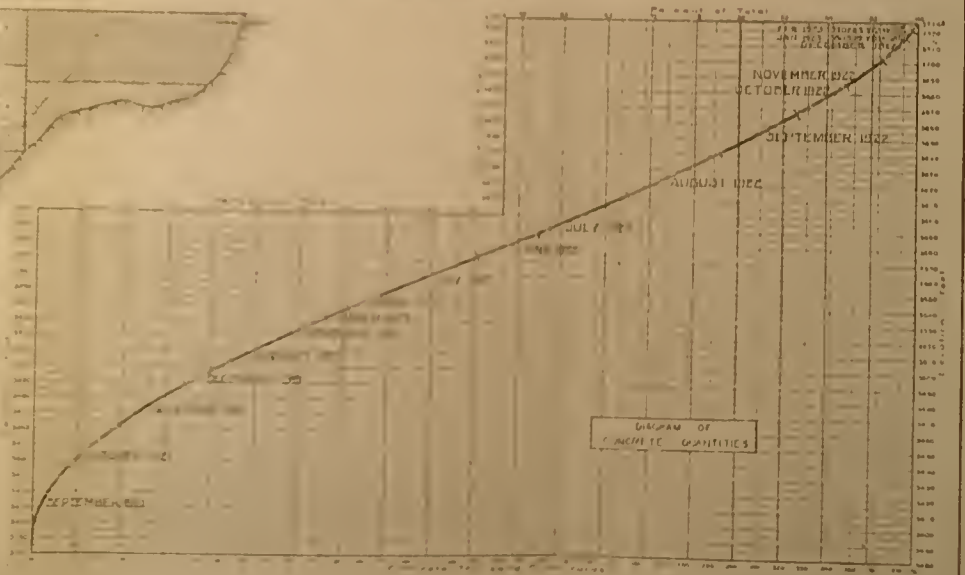




SECTION ALONG CONTRACTION JOINT NO 4
FOR PROGRESS BETWEEN CONTRACTION JOINTS NOS 4 & 5



LONGITUDINAL SECTION ALONG CUT-OFF TRENCH
(LOOKING UPSTREAM)



M M O'SHAUGHNESSY
CITY ENGINEER

continuously until January, 1922, when the foundation was completed to streambed level.

The amount of concrete in this portion of the structure is 77,346 cubic yards and includes the foundation for the future extension on the dam.

Concrete Above Streambed:

During the fiscal year 1921-1922, concrete above streambed, elevation 3,500, was carried to elevation 3,600, or 218 feet above the lowest point of the foundation. During the fiscal year 1922-1923, concrete pouring was completed to the crest of the dam, elevation 3,726.5 feet.

The following table shows the quantity of concrete placed each month:

1921	Cubic Yards
September	15,477
October	21,479
November	27,593
December	19,583
1922:	
January	24,823
February	15,219
March	10,980
April	12,866
May	41,178
June	26,845
July	37,550
August	39,007
September	27,949
October	23,626
November	17,443
December	9,879
1923:	
January	10,251
February	9,206
Total amount of concrete in dam exclusive of precast blocks, etc.	390,954

The progress in concrete pouring is shown graphically in the chart inserted herein.

Concrete was poured only on day shifts until December, 1921, when a night shift was started. From that time on, both night and day shifts were used. Concrete

pouring was continued in the cold winter months, using heated water and circulating pipes. All concrete was protected with canvas and oil heaters were used when the temperature was below freezing.

Large stone or plum rock was placed in the cyclopean masonry to the extent of approximately 6% of the mass. The plum rock is granite, quarried from the talus slopes on the north of the valley and loaded by steam shovel into narrow-gauge cars, in which it was transported to the damsite. Large steel guy derricks placed the stones in the freshly poured concrete.

The general plan followed was to pour the concrete in five-foot layers with the downstream face of the dam from five to fifteen feet higher than the upstream face. Five-foot steps were formed to key together successive layers of concrete.

Wooden forms consisting of 5-foot by 8-foot panels were used, held in place by 3/16-inch tie wires fastened with wire loops placed in the concrete during the previous pour.

Shaft and Tunnel Lining:

The 23 by 25 foot diversion tunnel was lined with a 12-inch concrete lining for a distance of 253 feet. A concrete plug was constructed in the tunnel. On the downstream side of this plug are three of the outlet conduits, with valves and operating chambers to control the discharge from the reservoir.

The shaft leading to the diversion tunnel was lined, and two 5-foot by 6-foot ladder wells formed within the shaft to connect with the operating chambers in the tunnel plug. These chambers are entirely independent of each other, which constitutes a safety factor in case of difficulty with any set of valves.

Concrete lining was placed in an adit to the diversion tunnel and a turbine chamber formed for the 40-horse-

power generating plant which will furnish light for the attendants' quarters, and the galleries and roadway of the dam. A shaft 70 feet in depth was sunk through the granite and lined to neat dimensions of 4 feet by 6 feet to give access to the turbine chamber.

Precast Concrete Blocks:

Ladder wells were formed on the contraction joints by forming each half of the well as a block in the block plant, and placing and fitting these on the plane of the joint slightly in advance of the concrete pouring.

Porous concrete blocks 3 feet 3 inches square outside measurement and with a 15-inch square cavity were cast in the block plant and placed near the upstream face, at 12½-foot intervals, to form a drainage system.

Mortar Placed by Cement Gun:

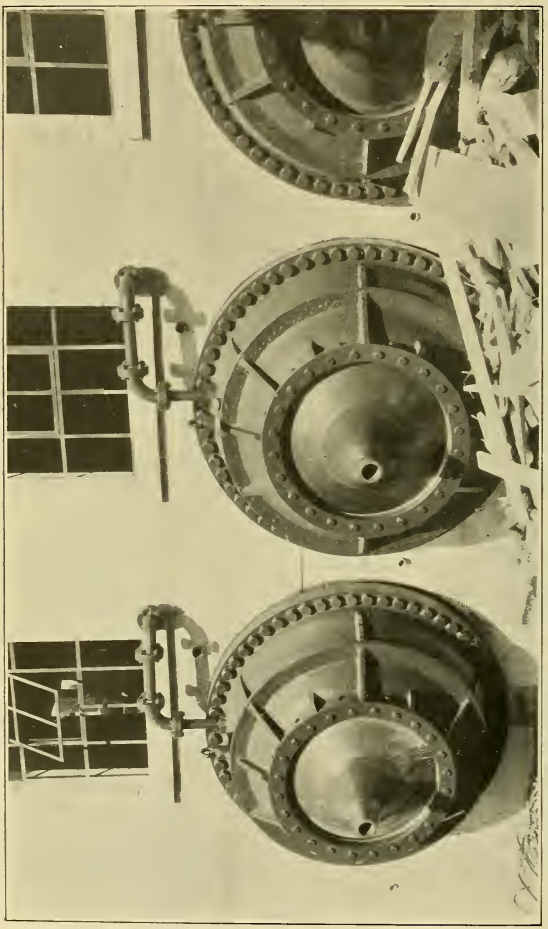
The entire upstream face of the dam, below streambed level, was coated to a thickness of one inch with mortar applied with a cement gun, and the area above streambed was coated with mortar to a thickness of ¾ inch.

Screen Racks:

Three screen racks guarding the entrances to the outlet conduits were built on the face of the dam. These consist of precast reinforced concrete screens supported on reinforced concrete columns and ribs and ranging in height from 60 feet to 112 feet. The screen racks cover all of the openings leading to the valves and serve to prevent any debris reaching and lodging in the valves.

Copper Water Stops:

Water stops made of 1/16-inch sheet copper are used to prevent seepage along the contraction joints. These pieces of copper were bent into a bellows shape and placed in the concrete in sections as the dam was built up, extending from the bottom of the structure to the top. Copper water stops were also placed along the top of the dam to seal the joint between the present crest of the



8-FOOT NEEDLE VALVES ON DOWNSTREAM FACE OF O'SHAUGHNESSY DAM

dam and the future extension. The copper water stops have been subjected to the test of a full reservoir and no seepage past them has been observed.

Valves for Outlet System:

Valves to control the discharge of water through the dam as required have been installed at various levels. Openings, designated as supply pipes, supply wells, and discharge conduits, have been cast in the concrete as the structure was built.

The valves consist of the following:

Six 5-foot balanced needle valves;
Six 3-foot balanced needle valves;
Six 47-inch by 90-inch slide gates;
Six 33-inch by 42-inch slide gates.

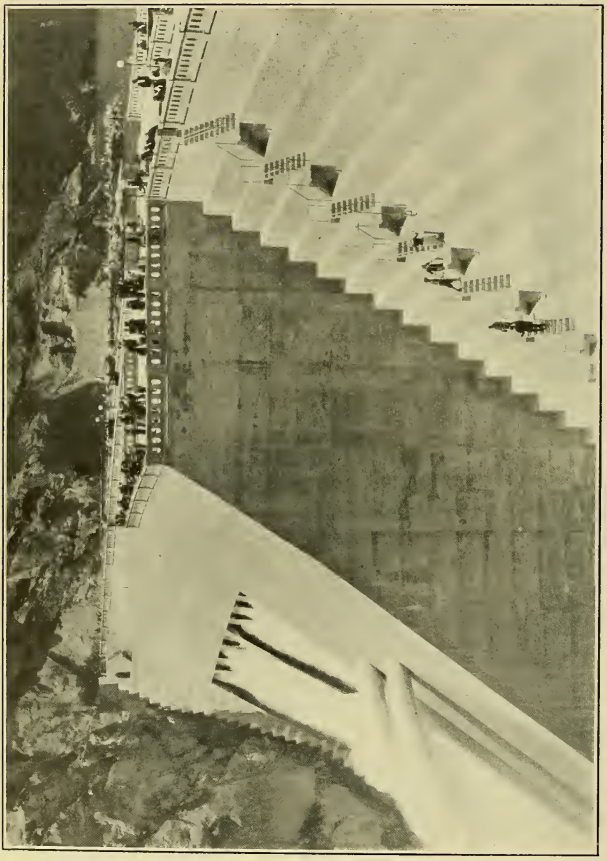
The valves and their appurtenances comprise over 2,000,000 pounds of metal.

On each opening through the dam there are two controls. The water is admitted through the hydraulically operated slide gate to the supply well and from there the required flow is regulated and discharged by the balanced valve. These valves are of the latest type of hydraulically balanced valve which permit manual control of a plunger, weighing five tons, under a high head of water.

The six 5-foot balanced valves and the six 47-inch by 90-inch slide gates are installed in the main portion of the dam, being encased in the concrete as the structure advanced. Three of the 3-foot balanced valves are installed on the lower side of the dam, at elevation 3,625, in a special valve house, and have three 33-inch by 42-inch gates installed in the dam in connection with them. Three 3-foot needle valves and three 33-inch by 42-inch slide gates are installed in the concrete plug in the diversion tunnel and permit draining the reservoir to its lowest levels.

Spillway:

The spillway of the dam consists of eighteen siphons, each about 4 feet by 10 feet, and placed in three series at



O'SHAUGHNESSY DAM, HETCH HETCHY WATER SUPPLY PROJECT
Showing stepped construction of downstream face and jets from two 5-foot outlet valves.

slightly different levels. The siphon openings were formed in the concrete as the structure was built and are heavily reinforced with steel. Each siphon has a capacity of approximately 1,000 cubic feet per second. The spillway has operated successfully since May 25, when the reservoir reached its flood limit. The water discharging from the siphons cataracts down the steps on the back of the dam and forms a waterfall of imposing appearance.

It is the plan, on the final completion of the dam to full height, to by-pass the floods through canals and tunnels past one of the abutments of the dam so as to clear the structure altogether.

Roadway on Dam:

The top of the dam is finished with a 17-foot roadway, on the sides of which are placed precast concrete railings. These railings give an artistic finish to the structure and are in keeping with the beauty of the landscape. A concrete girder bridge, connecting the dam to the newly built Eleanor Road, harmonizes with the main structure.

Inspection Galleries:

Interior stairways, leading to the streambed level from the top of the dam, are built from both ends. These stairways are connected by two cross-galleries, one at a point 41 feet below the crest and one at a point 225 feet below the crest. The stairways and galleries permit of interior inspection of the dam and give opportunity to observe the action of the porous drains and contraction joints.

Interior galleries are built on the upstream face of the dam for operating the large slide gates and 5-foot balanced valves. These galleries are reached through independent ladderways which were cast in the concrete as the structure was built up.

Roadways in Vicinity of the Dam:

A roadway has been built from the railroad and the operators' quarters to the south end of the dam. A roadway

has also been built from the north end of the dam connecting with the old Eleanor wagon road. This road skirts the reservoir and is cut out of the granite cliff which rises steeply from the water's edge.

Construction Plant:

The equipment installed by the contractor to carry on the construction of the dam has been described in detail in report of the Bureau of Engineering for 1921 and 1922 (pages 101 to 107). No important changes have been made during the past year.

Clearing Hetch Hetchy Reservoir:

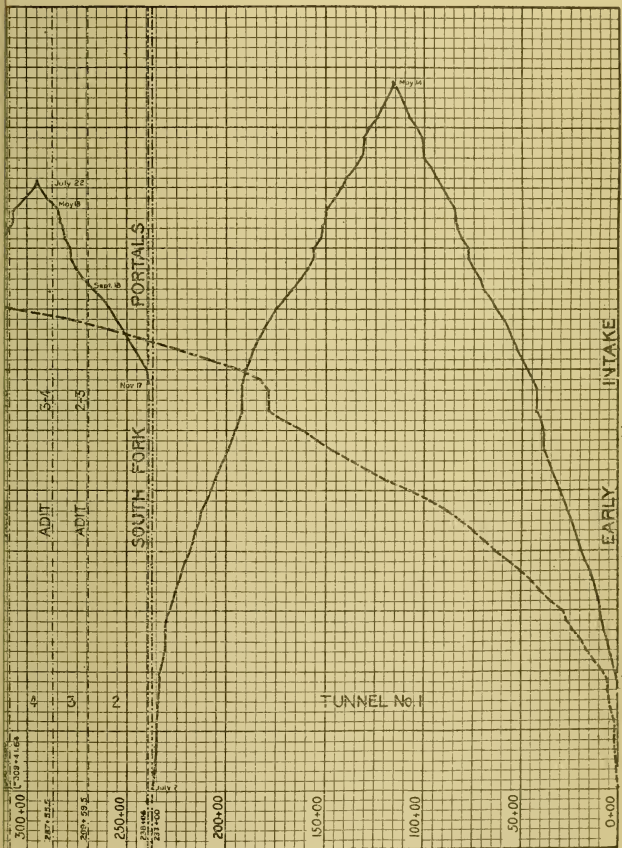
The clearing of Hetch Hetchy Reservoir, including the removal of all trees and brush and the burning of all grass and vegetation, has been completed during the past year. It consisted of cutting a growth of oak, pine, cedar and fir timber from about 900 acres in the Little Hetch Hetchy Valley and on the steep slopes of the main Hetch Hetchy Valley. Besides this, the second growth was cleared from approximately 700 acres of land in the main valley. The final work was performed just prior to the filling of the reservoir, so that the entire area was a clear, bare basin for receiving the first flood waters from the snow-covered mountains.

In the clearing operation 12,000 cords of wood were obtained and utilized in the construction work as fuel for nine steam dinky locomotives, for steam shovels and derrick engines and for camp heating and cooking.

Aqueduct Tunnels.

Excavation of the aqueduct tunnels between Early Intake and the regulating reservoir at Priest is proceeding under Contract 77-C with the Construction Company of North America. Good progress was made in the past year, although the work was delayed for about a month in November, 1922, by a strike instigated by radicals.

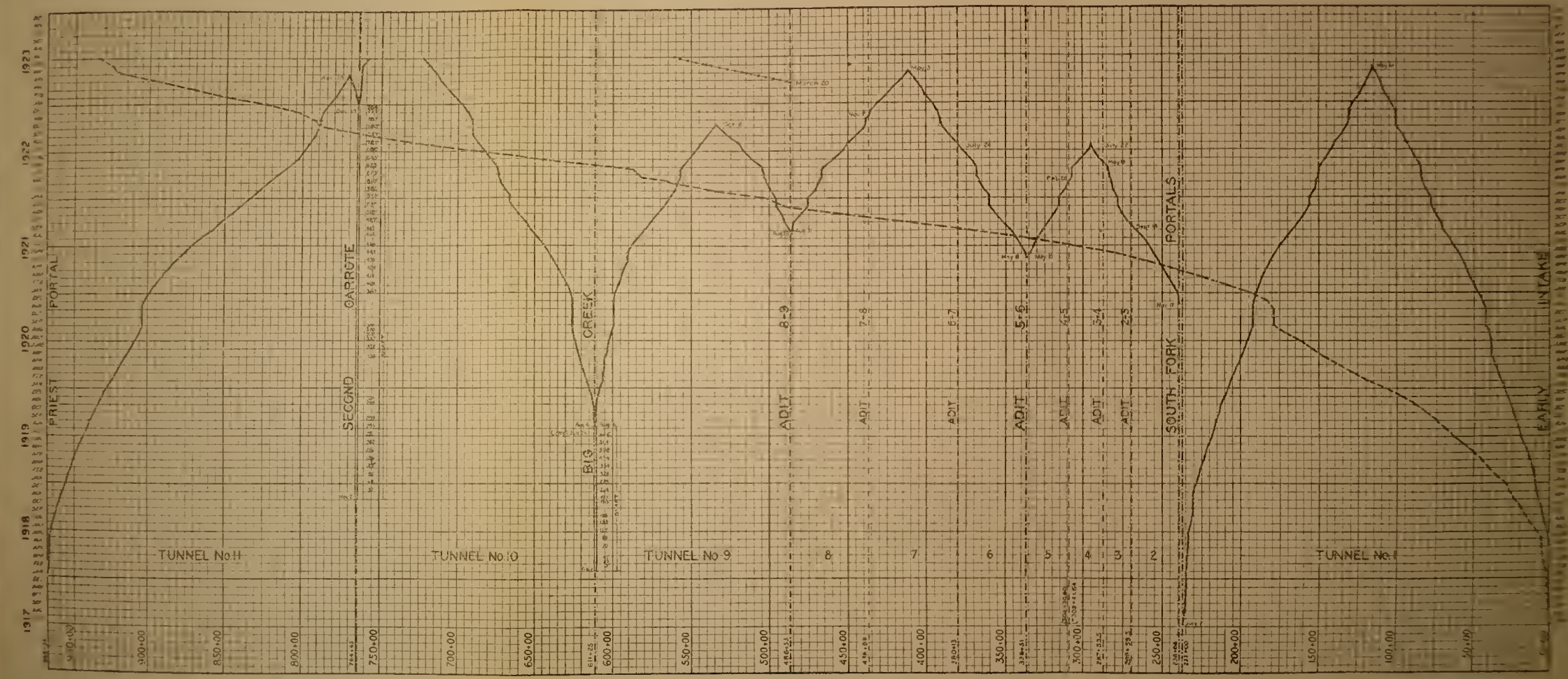
I DIVISION
RT



M. M. O'SHAUGHNESSY
CITY ENGINEER

HETCH HETCHY AQUEDUCT - MOUNTAIN DIVISION

TUNNEL PROGRESS CHART



LEGEND

EXCAVATION INDIVIDUAL HEADINGS ——— , TOTAL, ALL HEADINGS - - -
LINING " " - - - - " " " ———

M.M. O'SHAUGHNESSY
CITY ENGINEER

On July 1, 1922, ten headings were being worked, namely: Early Intake, South Fork crossing (east and west), Adit 5-6 (east and west), Adit 8-9 (east and west), Big Creek Shaft (east and west), and Priest Portal. During the year the Second Garrote shaft was completed and two more headings were begun from the bottom of the shaft, while five sections of tunnel were holed through. This leaves two headings, Big Creek Shaft West and Second Garrote Shaft East, working toward each other, and separated on June 30, 1923, by 4,362 feet.

The following table shows the progress in excavation for the fiscal year 1922-23:

Excavation in Feet

Heading	To be Lined or Unlined	Previous to July 1, 1922	July 1, 1922, to June 30, 1923	Total to June 30, 1923
Early Intake	Unlined	9,133	2,499	11,632
South Fork East	Unlined	9,412	2,647	12,059
South Fork West	Unlined	5,445	154	5,599
Adit 5-6 East	Unlined	4,035	222	4,257
Adit 5-6 West	Unlined	4,070	940	5,010
Adit 5-6 West	Lined	.....	2,425	2,425
Adit 8-9 East	Lined	3,217	4,351	7,568
Adit 8-9 West	Lined	3,016	1,756	4,772
Big Creek East	Lined	6,368	1,332	7,700
Big Creek West	Lined	7,149	4,036	11,185
Second Garrote East	Lined	.....	632	632
Second Garrote West	Lined	.....	642	642
Priest Portal	Lined	17,034	2,813	19,847
	Total....	68,879	24,449	93,328

The tunnel has two standard cross-sections: an unlined cross-section 13 ft. 4 in. by 13 ft. 6 in. for the harder rock formation, and a concrete-lined section 10 ft. 3 in. in height and width inside the lining, used in less stable or more pervious rock.

A detailed description of plant and equipment used in excavating the Mountain Division tunnels is contained in the report of this Department for the period 1920-22. A brief description of the work at the individual working points during the past fiscal year follows. The accompany-

ing chart illustrates graphically the progress of tunnel excavation and lining between Early Intake and Priest Portal.

Early Intake:

No changes were made in the plant and equipment at this camp, and though delayed by the disorganization due to the walkout and a break in the Lower Cherry ditch, good progress was made until the heading holed through to South Fork on May 14.

There remains to be done at this camp the widening of 3,300 feet of tunnel that was originally driven to the narrower dimensions for concrete lining, but is now to be left unlined. It is expected that this work of enlarging will be completed by September 15 of this year.

South Fork:

The west heading from South Fork camp holed through to Adit 5-6 on July 22, 1922. After widening 700 feet of tunnel from the lined to the unlined section of 13 ft. 4 in. by 13 ft. 6 in., this camp, located in the canyon close to the portal, was abandoned and torn down. Excepting the compressors and blower, all the plant was removed. Thereafter the east heading was worked from the 5-6 camp and all such work as sharpening steel, repairing mucking machines, etc., was done at 5-6. Good progress was maintained in the east heading and the tunnel was holed through to Early Intake on May 14, 1923.

About 3,500 feet of tunnel driven to the lined section remains to be widened to the dimensions for unlined tunnel, and this work should be completed by October, 1923.

Adit 5-6:

After the holing through to South Fork in the east heading from Adit 5-6, the 5-6 west and the South Fork east headings were driven from this camp.

The ground in the west heading changed to such an extent that it became necessary to drive the 11-foot 3-inch section for lining. This change was made at Adit 6-7 in

September. The heading was finally holed through to Adit 8-9 on May 3, 1923. Work is now in progress in trimming this section preparatory to concrete lining.

Adit 8-9:

Exceptional progress was made in both headings working from this camp. The 11-foot 3-inch section, for lining, was driven in a formation of quartzite, schist and slates. The west heading holed through to Big Creek on October 8, and this section was trimmed and made ready for the concrete operations.

The east heading holed through to 5-6 on May 3. Trimming is in progress and this section will be ready for the concrete lining by August.

The greater part of the plant has been removed to other work.

Big Creek Shaft:

After holing through the east heading to Adit 8-9 on October 8, 1922, and trimming this for concreting, all efforts were centered on advancing the west heading, since progress in this is the controlling factor in the time of completing the Mountain Division tunnel. Considerable water was encountered which flooded the heading for a month last September and necessitated the shutting down of operations at the face until additional pumping equipment could be installed. After starting up for one day, the work was still further hampered by the radical strike. Since resuming operations in November, good progress has been maintained. The formation is still in a metamorphosed slate and quartzite, and water-bearing seams are frequently encountered.

After holing through the east heading to Adit 8-9, Myers-Whaley mucking machines, which could not be taken down the shaft, replaced the smaller Hoar shovels, and are now in use in the west heading.

The excavated material is hoisted to the surface through Big Creek Shaft, and the fines and coarse aggregate

separated, crushed, and stored in bunkers for use in the concrete lining. When these bunkers are filled, the balance is passed through a large gyratory crusher and used for ballast on the Hetch Hetchy Railroad, for road maintenance and for concrete. A revolving screen has been installed at this crushing plant and the fine material is being hauled to Cavagnaro for use as sand in the penstock piers.

Second Garrote Shaft:

Sinking of the Second Garrote Shaft was carried on continuously, and tunnel grade, 754 feet below the collar, was reached on August 27. A station was then cut and the shaft continued to 786 feet for a sump and rock pocket.

The flow of water into the shaft, which was gradually decreasing as the Priest tunnel heading advanced into the water-bearing formation, continued through the whole time of shaft excavation.

Drifting was started in both directions on December 19. After advancing the east heading 161 feet with practically all the water in the face, this heading was shut down and all work concentrated on advancing the west heading to meet that from Priest. This was accomplished on April 25, 1923, and all danger of flooding the shaft was ended, since the water could flow out by gravity through Priest Portal. Work was then resumed in the east heading, and though the face continues wet, good progress is being made. It is expected that this heading will hole through to Big Creek in October.

Hoar mucking machines released from Big Creek were taken down the shaft when drifting started, but as soon as the west heading was holed through to Priest, Myers-Whaley machines were taken in from that end and are now in use in the east heading.

Priest Portal:

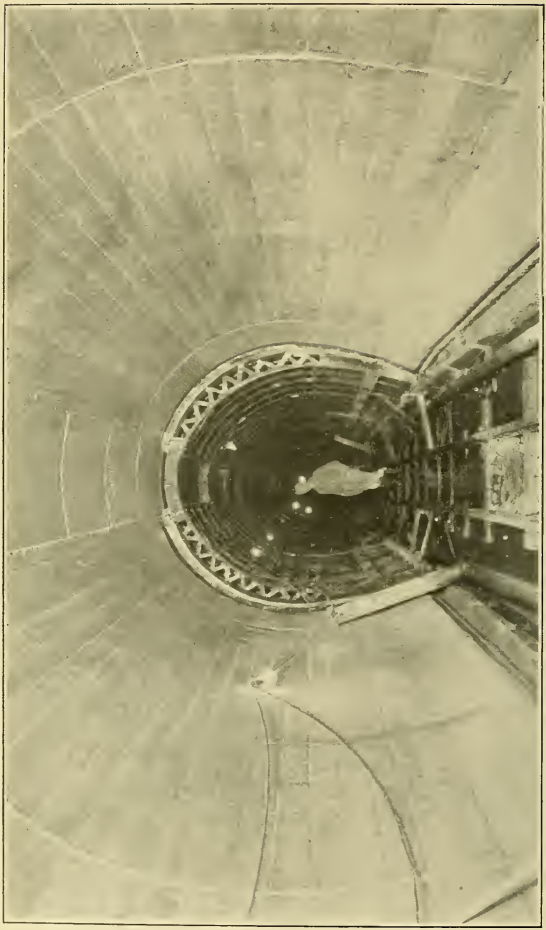
As this heading advanced into the diorite, the increasing flow of water encountered and the long haul of 3½

miles to the portal added to the difficulty of excavation, yet good progress was maintained, and the tunnel holed through to Second Garrote on April 25, 1923. The tunnel is now being trimmed preparatory to lining.

Tunnel Lining:

The tunnel will be lined with concrete from Adit 6-7 to Priest Portal, a distance of 58,275 feet. The lining program provides for placing side walls and arch from Adit 8-9 to Big Creek first; then moving the lining plant to Adit 6-7 and placing the side walls and arch from Adit 6-7 to Adit 8-9; after which the invert will be placed from Adit 6-7 to Big Creek. On the completion of the invert it is expected that the tunnel between Big Creek and Second Garrote will have holed through and concrete operations will start at Second Garrote and work back toward Big Creek. In the meantime as soon as the tunnel is trimmed, lining operations will start at Second Garrote and work forward to Priest Portal.

The sand, rock and cement for the concrete are stored at Big Creek and Priest Portal. At Big Creek the measured dry aggregate for one 3-sack batch is fed onto conveyors and dropped down a pipe, 575 feet to the tunnel level. Initially the old 18-inch ventilating pipe was used for this purpose, but this has lately been replaced with the 10-inch discharge pipe moved from Garrote. The aggregate is there loaded into bottom dump cars, having three compartments, each holding one batch. A train of six cars, or eighteen batches, is hauled by an electric storage battery locomotive to the point where lining is in progress. The dry concrete material is dropped from the cars, a batch at a time, onto the conveyor belt of a special portable mixing plant mounted on the tunnel track. The material is conveyed to a hopper, fed into a Ransome No. 14-S mixer operated by a 10-horsepower motor. The necessary water is added and, after thorough mixing, concrete is discharged into a Webb concrete gun and shot into place back of the forms by compressed air.



AQUEDUCT TUNNEL ON MOUNTAIN DIVISION OF HETCH HETCHY WATER SUPPLY PROJECT.
Concrete lining of sides and arch and collapsible forms in place.

The forms, which are of the Blaw collapsible type, are in sections 20 feet long and are made up of steel framework with wood lagging. They are moved on a carriage or traveler running on the 24-inch gauge tunnel track.

Similar equipment is being assembled at Priest Portal and will be ready to enter the tunnel as soon as the trimming is completed.

The lining of sides and arch was started at Adit 8-9 on March 17, 1923, working westward, and an average of 73 feet per day has been maintained. It is hoped to improve this to 100 feet per day.

The Big Creek plant, crushing the tunnel muck for sand and rock, has operated continuously through the year. Two Clyde electric hoists were added to the plant, one to drag in the rock from the old dump to the crushers and the other to convey the crushed material to the hoppers. A spur track from the Hetch Hetchy Railroad, 1,260 feet long, was constructed for the purpose of delivering cement directly to the work. A cement warehouse 30 feet by 80 feet, with a capacity of 9,000 sacks, was built convenient to the shaft.

At Priest Portal the rock crushing plant operated practically without interruption and the sand output was increased by the installation of a No. 2 Hendy sand roll to recrush rock for sand. A cement warehouse and bunkers for rock and sand have been built directly over the portal, on the line of the tramway. It is expected that lining operations will begin from this point by October 1.

Early Intake Diversion Works.

Preliminary plans for the Early Intake diversion dam were completed in October, 1922. It will be an arch of thin section on a short radius, with a length along the crest of about 200 feet, and a total height of 85 feet from crest of dam to bottom of excavation. The spillway will be a channel around the north end of the dam and will have a capacity of 20,000 cubic feet per second.

Work was begun in October on the installation of a plant to handle this construction. A rock-crushing plant consisting of a No. 3 Gates primary crusher and a No. 2½ Wheeling crusher, with the necessary conveyors, was set up near the portal of the aqueduct tunnel. The spoil from the tunnel is crushed into fine and coarse aggregate, hauled by truck to the site of the dam and stored. The fines output is further augmented by a No. 2 Hendy sand roll installed at the dam, some of the rock being crushed into fines for sand.

Excavation has been completed for the foundation of the concrete pier that will form the north abutment of the dam, and a concrete pier to serve as a derrick footing, to be incorporated into this main abutment pier has been poured to the crest height.

The construction of the spillway involves the moving of approximately 30,000 cubic yards of earth and loose rock. A one-half yard Marion traction revolving steam shovel is being used for this purpose, work having been started early in May.

The problem of stream diversion in the construction of this dam will be rendered very simple by virtue of the completion of the O'Shaughnessy Dam. After the spring runoff, the Hetch Hetchy Reservoir will be drawn down about 40 feet and the valves shut, cutting off the flow in the Tuolumne at the dam, the storage capacity being ample to take care of the normal river flow above the dam for the three or four months necessary to construct the dam.

The connection from the diversion dam to the aqueduct will be a tunnel well back in the hill, 2,900 feet long. It will connect with the main aqueduct tunnel 500 feet inward from its present portal. The connecting tunnel will be commenced as soon as work in the main aqueduct tunnel is completed.

Moccasin Creek Power Development.

Priest Earth Dam:

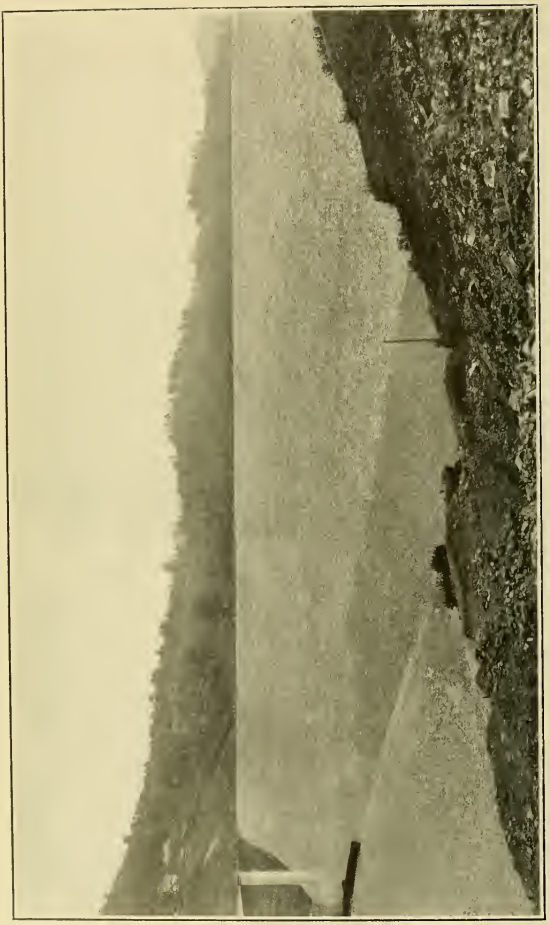
The concrete core wall of Priest Dam was completed on May 1, with a total volume of 17,044 cubic yards. Work on the earth fill has been carried on without interruption. A total of 247,556 cubic yards of earth was placed by the hydraulic method in the upsteam portion of the dam, completing same to within about 20 feet of the top. The remainder of the fill is being made by dumping on both sides from a track laid on top of the core wall. A pool in front of the dump on the upsteam face keeps the fine material against the core wall. A total of 568,800 cubic yards, or 92% of the entire earth and rock fill, has been placed to date. The upstream face of the dam is being riprapped, using spoil from the Moccasin Creek Power tunnel. Excavation has begun on the spillway section, and it is expected that the dam will be completed in September.

The six-foot diameter auxiliary outlet tunnel through the dam, 900 feet in length, has been lined with concrete, the 30-inch valves installed and put in operation and the concrete outlet tower completed.

Power Tunnels:

The connection between Priest Reservoir and the Moccasin Creek penstocks will be by a main tunnel and three branches. A single tunnel will extend from the reservoir 5,394 feet into the hill to a surge shaft, where it will branch into three parallel tunnels, each 555 feet long, and ending on the hillside above the power plant.

The main tunnel is to be concrete lined, of a horseshoe section 13 feet in height and width. The concrete lining will be nine inches in thickness. The three branch tunnels from the surge tank to the penstocks are to be of horseshoe cross-section 10 feet 3 inches in height and width. In these three tunnels are to be placed and concreted in, the upper ends of the 104-inch steel penstocks.



PRIEST DAM, MOCCASIN CREEK POWER DEVELOPMENT
Upstream face, showing riprap paving and gate tower.

The surge chamber or shaft will be 40 feet in diameter inside its concrete lining. It will extend vertically from the invert of the tunnels to 50 feet above the ground surface, a total height of 160 feet. Excavation of a 6-foot by 8-foot pilot shaft on the site of the surge tank was begun on May 29.

East Portal: This heading was opened in June, 1922. Good progress has been made in the formation of andesite, a total of 2,790 feet being driven in the past year. Some soft ground was encountered which required timbering.

Muck cars, electric locomotives and Myers-Whaley mucking machines released from the Mountain Division tunnel are in use here. The spoil from the power tunnel is hauled to the Priest crushing plant to be crushed into rock and sand for concrete. All excess rock is used for riprap on the upstream face of the Priest Dam.

The camp at Priest dam and reservoir was enlarged to accommodate the men working in this heading. A blacksmith shop, machine shop, blower house and powder house were built and an additional compressor installed at the Priest Portal plant, to furnish air to this heading.

West Portal: A new camp of standard construction, accommodating 120 men, was built in the early fall on the ridge about ¾-mile west of Priest Hotel, and work was started on the west portal of the power tunnel and on the excavation for the penstocks.

Tunnel No. 2, the center tunnel, was faced on February 3 and good progress made, considering the nature of the ground, which required continuous timbering. Tunnel No. 1 of the penstock tunnels was faced on March 1 and was driven to the surge tank on June 15. The third tunnel will be commenced and carried ahead as circumstances will permit of working to the best advantage.

At the location of the surge tank the excavation was widened preparatory to raising, and beyond, the section

was changed to conform to that of the main tunnel being driven from the east portal. Our program calls for the main tunnel to hole through early in October, 1923.

A complete tunnel plant consisting of compressors, blowers, sharpeners, Myers-Whaley mucking machines, etc., released from the upper aqueduct tunnel work, was installed at the west portal. A rock-crushing plant consisting of a No. 4 McCully primary crusher and a No. 2½ Wheeling crusher, with the necessary bunkers, screens and conveyors, was also installed. The spoil from the tunnel is crushed into coarse and fine aggregate for lining the power tunnel and for piers to support the penstock lines.

Moccasin Creek Penstocks:

The upper end of the penstocks will be riveted and the lower end welded steel pipes. Three 104-inch steel pipes will extend back in the tunnels to the surge chamber. Three valves will be installed at the tunnel portals. Initially one of the lines will be terminated at this point and two lines extended down the hill a short distance to a point where each will branch into two lines, one for each of the four power units. These four pipes will each be 70 inches in diameter below the Y branch, reducing in size until at a point just back of the power house they are 57 inches in diameter. At the power house, each pipe again branches into two 48-inch pipes leading to the separate wheel nozzles. The third line will be extended similarly from the valve at the tunnel portal, when, at some future time, the additional units, for which the power plant has been designed, are installed.

The horizontal length of the penstock line is 5,369 feet, and the penstock pipes for the four power units will contain about 11,948,000 pounds of steel. The pipe is to be manufactured by M. W. Kellogg Company of New Jersey, and by the Western Pipe and Steel Company of California, under contracts, as previously noted. The installation will be done directly by the City.

SITE OF MOCCASIN CREEK POWER PLANT
Showing excavation for power house and penstocks.

Grading for the penstocks, involving the moving of 51,000 cubic yards of material, was started early in July of last year and completed in January, 1923. At the crossing of the Hetch Hetchy Railroad at Cavagnaro additional excavation was made to accommodate the concrete anchorage block that will be located at this point. The Hetch Hetchy Railroad is carried over the excavation on a new framed trestle 100 feet long, the bents so located that they will not interfere with the placing of the steel pipes.

A tramway to distribute the pipe along the line of the penstock has been constructed and a single drum hoist driven by a 250-horsepower motor, with a capacity of 25 tons on the maximum grade, has been installed at the top of the hill to operate the tram.

At Cavagnaro, bunkers have been erected into which sand and rock are dumped for use in the concrete of the penstock saddles and piers.

Power Plant Equipment:

As indicated in last year's report, Contract No. 79-A was awarded April 28, 1922, to the Pelton Water Wheel Company for furnishing four 25,000-horsepower 257 R. P. M. water wheels; Contract No. 79-B, on April 18, 1922, to the Coffin Valve Company of Boston, for the eight 36-inch hydraulically operated gate valves to control the flow of water to the water wheel units; and Contract No. 80, on May 1, 1922, to the General Electric Company, for four 20,000-kv-a. 11,000-volt, 3-phase electric generators with direct connected exciters for use with these water wheels.

Contract No. 81 was awarded August 18, 1922, to the Westinghouse Electric and Manufacturing Company, for thirteen 6,667-kv-a. 11,000 to 89,000 volt transformers, and for all of the switching equipment necessary to control the four generators and the two transmission lines leaving the power house.

All of these companies have been vigorously prosecuting their work, with the result that practically all of the

MOCCASIN CREEK POWER PLANT EQUIPMENT
Showing runners for 25,600 H. P. impulse water wheels and 6667 kv.-a., single phase, 60 cycle, outdoor type transformers.

equipment covered by the several contracts, with the exception of the valves from the Coffin Valve Company, are at the power house site, en route, or at the factories waiting the time specified in the contract for making shipment.

Additional contracts were awarded during the year as follows:

Contract No. 70 for an electric traveling crane for the power house, was awarded to Pawling & Harnischfeger of Milwaukee on December 8, 1922, in the sum of $30,475.

Contract No. 82 for structural steel for the power house building was awarded February 23, 1923, to the Union Construction and Drydock Company, for the estimated sum of $60,720.

Transmission Line:

The following contracts for transmission line conductors were awarded during the year:

Contract No. 78 for electric transmission line conductors was awarded June 15, 1923, to the Anaconda Copper Mining Company, who are to supply 177 miles of 345,000 circular mill hemp core copper cable weighing 5,796 pounds per mile, the price per pound being 18.65 cents, and the total price, $191,328.86.

Contract No. 89 for steel reinforced aluminum cable was awarded to the Aluminum Company of America, on January 26, 1923. This covers the furnishing and delivering of 530 miles of 397,500 circular mill steel reinforced aluminum cable, weighing 3,284 pounds per mile, at a price of 21½ cents per pound, making a total of $374,211.80.

Contracts for transmission line towers, suspension insulators and line hardware are in course of preparation, and will be awarded in ample time to secure deliveries of material to commence construction of the transmission line early in 1924.

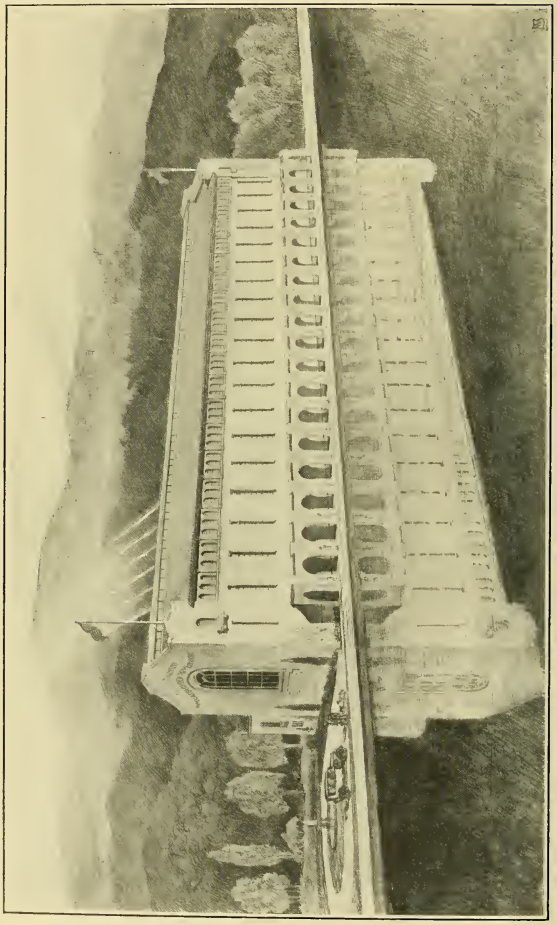
Surveys have been completed for the transmission line right of way from San Francisco Bay to the power house,

and a considerable portion of the right of way across the San Joaquin Valley has already been purchased. Across the Valley, the transmission line and aqueduct pipes will occupy the same right of way, 110 feet wide. From the east side of the San Joaquin Valley to the power house, and from the west side of the Valley to the Bay of San Francisco, separate rights of way can be used more advantageously. That for the transmission line will be 100 feet wide.

The widths of right of way will provide sufficient space for two double circuit towers, making it possible to connect San Francisco with the Hetch Hetchy project by four circuits, each capable of carrying 50,000 kilowatts at 154,000 volts, or a total of 200,000 kilowatts from the mountains to the City. The materials now being purchased are for the installation of but two of these circuits. Operating the two together, as will normally be the case, will permit of very efficiently carrying the power to be generated at the Moccasin Creek plant, and when one line must be taken out of commission temporarily, the remaining circuit will be able to transmit the output of the plant to San Francisco at a reasonable efficiency.

Power House Building:

The building for the power house, designed under direction of the City Engineer by Mr. H. A. Minton, Architect, is to be of the old Spanish Mission style, which is particularly typical of this state and which, with its wide arcades on each side, lends itself admirably to the purpose. The arcade on the side of the building toward the penstocks will house the hydraulically operated gate valves controlling the water to the wheels. The arcade on the tailrace or discharge side of the building will be utilized to provide for the air inlets for cooling the generators and to support, outside of the building proper, the baffle plates against which the jets from the auxiliary relief nozzle will impinge. By this arrangement it was possible to gain one foot in the available pressure head with corresponding increase of output.



MOCCASIN CREEK POWER HOUSE
(From drawing of proposed structure.)

The power house will be a steel frame building with concrete walls, floors and roof slab. The walls will be waterproofed on their exterior surfaces with a coat of cement plaster applied by means of a cement gun. The roof will be covered with red tile. The exterior of the building will be plain, depending on its proportions and form to make the assembly very pleasing to the eye.

The high tension bus bars and oil switches and the transformers are of the outdoor type and will be placed in the open immediately behind the building, the high tension conductors being supported on a structural steel framework.

Housing accommodations for the power house operators and attendants will be adequately provided for. There is being laid out a small community for ultimately 15 dwellings, a school house, community garages and a club house. The general treatment of these buildings will conform to the architecture of the power house.

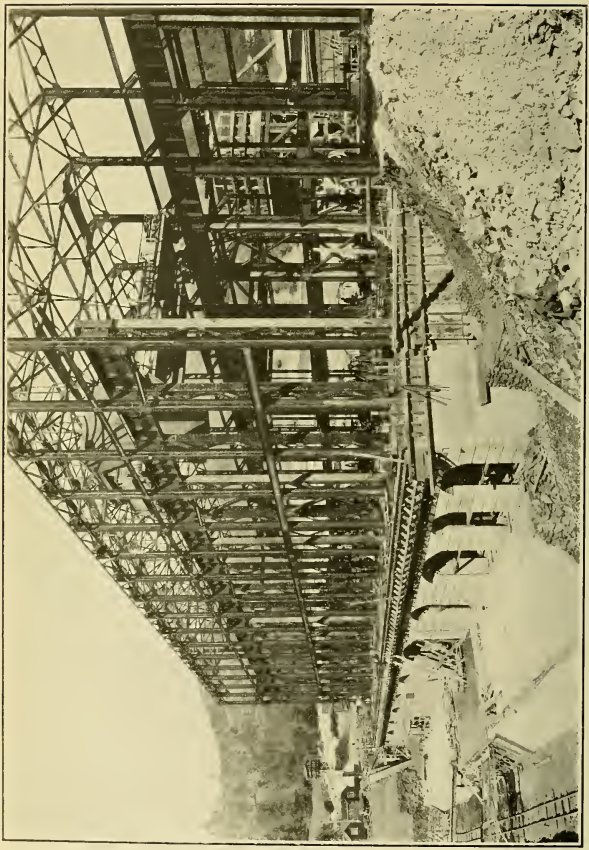
The club house will contain quarters for the single men and an assembly hall to be used as a community center. It will have twelve sleeping rooms, a dining room to accommodate from twenty-five to thirty persons, and a large living room in which the gatherings of community interest may be held.

Cottages will be four and five rooms, alternate buildings being of fireproof construction so as to reduce the fire hazard, which may at times be menacing on account of forest fires in the vicinity. Only six of the dwellings are to be built initially; others will be added as needed.

As an adjunct to the power plant there will be underground storage for oils, with a small fireproof surface building in which the oil storage control will be centered, thus eliminating all oil fire hazard from the power house building proper.

Power Plant Construction:

A spur, 7000 feet long, from the Hetch Hetchy Railroad to the power house site was ballasted and put in service,



MOCCASIN CREEK POWER HOUSE

Construction view showing discharge outlets to tailrace and structural steel frame.

and material and equipment for the power house construction were hauled directly in. Temporary and permanent yard tracks were laid adjacent to the building site. An eight wheel traveling locomotive crane, for use in handling the heavy power house machinery and steel pipes, was purchased from the Link Belt Company. The crane is steam operated and has a fifty foot steel boom with a fifteen foot intermediate removable section.

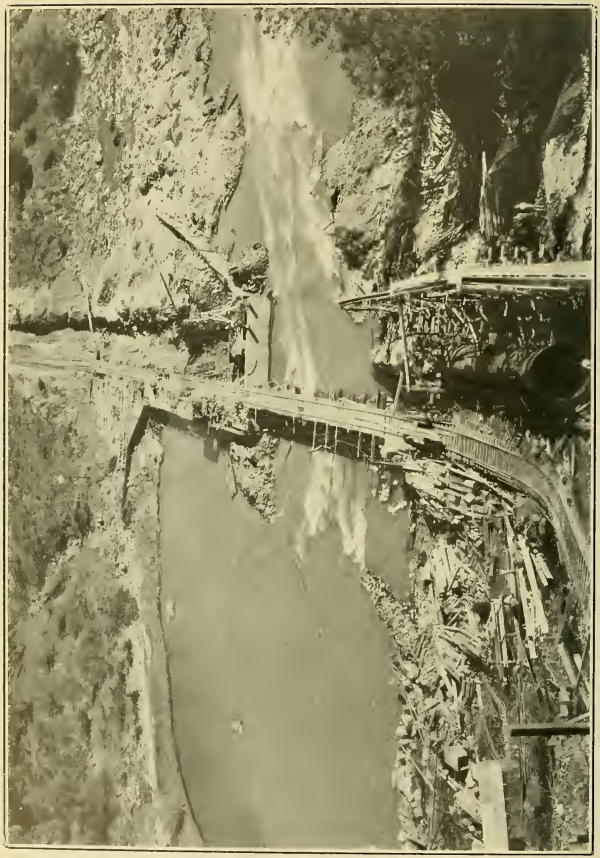
A machine shop building 55 by 81 feet, equipped with a 10-ton traveling crane, has been completed and is ready for the equipment that has been ordered. A warehouse 40 by 80 feet for general material, together with one for electrical material, has been erected and both are in use. A bunker for sand and rock was built under the trestle of the Moccasin Creek railway spur which crosses the penstock excavation, and aggregate is being stored for use in concrete on the power house foundation.

Steam shovel excavation was started at the power house site on February 1 and completed on May 1. A total of 40,000 cubic yards was moved. The spoil was hauled with dinky locomotives to the old hydraulic workings on Moccasin Creek, one-half mile south of the site, and leveled off to a neat appearing hill.

On July 1, 1923, all of the excavation for the power house and for the penstock had been completed, and forms for the power house and machine foundations are well under way. The reinforcing steel and mechanical parts to be set into the foundations are being placed and concrete materials are on the ground ready to commence pouring concrete. The power house foundations will be complete, ready for erection of the structural steel by September 15. The steel erecting will take about forty-five days after completion of the foundations.

Red Mountain Bar Siphon.

The completion of the Don Pedro dam of the Turlock and Modesto Irrigation Districts and the desire of the dis-



RED MOUNTAIN BAR SIPHON OF HETCH HETCHY AQUEDUCT.
9' 6" steel pipe with concrete jacket being laid across the Tuolumne River.

tricts to store the 1923 spring runoff, necessitated the construction, at this time, of that portion of the Red Mountain Bar siphon lying within the reservoir site.

This section, with the ends extending well above the elevation of the dam crest, is of riveted steel pipe, 9 ft. 6 in. in diameter and is 771 feet long. The thickness of the steel varies from 3/4 inch to 9/16 inch. The pipe is lined with cement mortar 2¼ inches in thickness, leaving the net diameter 9 feet 1½ inches. The siphon is designed to carry the entire flow of the aqueduct of 400 million gallons per day.

A camp accommodating 100 men, and a plant including tramway, bunkers, etc., was constructed on the west side of the Tuolumne River near the crossing. Excavation was started in the main channel in November, the water being diverted by means of a cofferdam around the work. This section was rushed with all possible speed. Early fall rains hampered the work and in December, when 12,000 sec. ft. of water passed down the river, a small section of the cofferdam was washed out. The pipe was laid on bed rock and encased in an envelope of concrete, from 18 inches to 24 inches in thickness. After concreting this section, the river was turned back in its channel over the pipe and a cofferdam thrown around the east channel. No unusual difficulties were encountered on the remainder of the work and the siphon was completed on June 1, in time to permit the Modesto and Turlock Irrigation Districts to close the gates of the Don Pedro dam and fill the reservoir for this season's irrigation.

Evidences of the forty-niners were found in the excavation in the shape of old cribbing placed on the bed rock to divert the river and permit working of the gold bearing gravel.

Sixbit Gulch Bridge.

As the impounded water of the Don Pedro reservoir at crest elevation would be some four feet above the deck of

the Hetch Hetchy Railroad trestle across Sixbit Gulch, it was necessary to replace this structure with another, higher in elevation. Plans and specifications were prepared by the City Engineer for a plate girder bridge 585 feet long, consisting of nine single track open deck spans each 65 feet long, with concrete abutments and piers. The new structure is 15 feet higher in elevation and 30 feet upstream from the old trestle.

The bridge was built under Contract 86 by the Union Construction Company. Abutments and piers for the bridge, containing approximately 2250 cubic yards of concrete, were placed by the Schultz Construction Company, under Contract 87. The change from trestle to bridge required the relocation of about 1800 feet of railroad track, and bids were also called for the grading required by this relocation. Contract No. 88, which involved the moving of 7200 cubic yards of material, 85% of it solid rock, was let to Martin J. Lyons.

Considerable delay was experienced awaiting the receipt of the steel plates from the Eastern mills, but the bridge was completed and turned over to traffic on May 1. The old trestle was afterward removed and the timber salvaged for other work.

The Turlock and Modesto Irrigation Districts, owners of the Don Pedro dam and reservoir, are bearing the entire expense of the bridge and railroad relocation with the exception of $6300, which has been agreed on as the saving against depreciation between the wooden trestle and the steel and concrete structure.

Hetch Hetchy Railroad.

The Hetch Hetchy Railroad is operated as a common carrier, transporting freight, passengers and United States mail between Hetch Hetchy Junction and Damsite. Trains are operated on regularly established schedules for both freight and passenger travel.

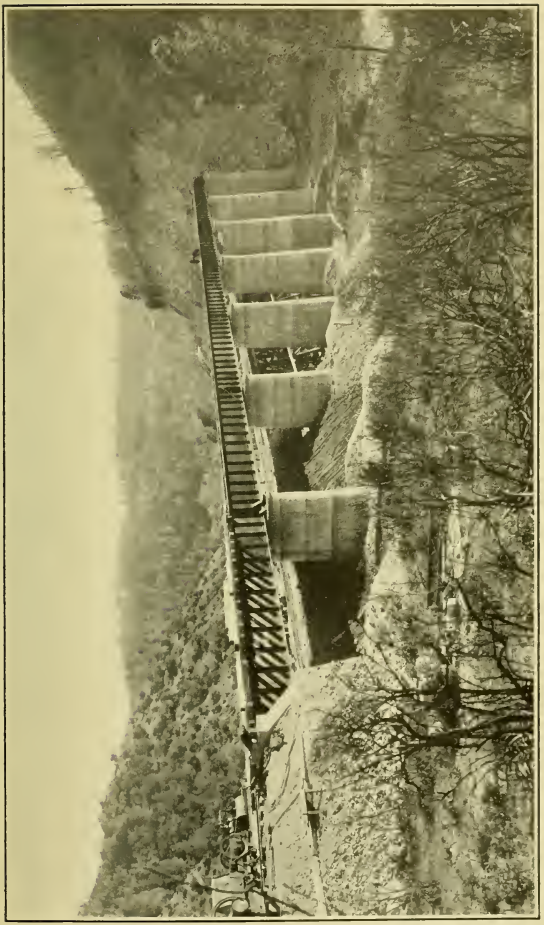


PLATE GIRDER BRIDGE
At Six Bit Gulch on the Hetch Hetchy Railroad.

Freight Haul:

With the completion of the O'Shaughnessy Dam, freight haul decreased materially. This decrease has been offset somewhat by heavy shipments of lumber from the sawmill of the California Peach and Fig Growers Association at Mather to Hetch Hetchy Junction, and from our own mill at Mather to Moccasin Creek.

Passenger Traffic:

Daily passenger service on mixed trains has been maintained between Hetch Hetchy Junction and Groveland, and by truck buses between Groveland and Mather. Traffic to and from the Oakland Recreation Camp at South Fork has been heavier than in previous years, and a larger number of passengers to and from the Berkeley Camp have been carried over the railroad. The one day trip operated by the Yosemite Transportation System from Yosemite to Hetch Hetchy and return, via Hetch Hetchy Railroad from Mather to Hetch Hetchy, shows increasing popularity. An unusually large number of automobile tourists have availed themselves of the opportunity thus offered to visit the O'Shaughnessy Dam. This business has been taken care of by two truck buses operating on schedule between Mather and Hetch Hetchy, supplemented by steam train service when required. Bi-weekly excursions have been run from South Fork to Hetch Hetchy for the benefit of visitors at the Oakland and Berkeley Camps, and have proved popular.

A series of week-end excursions were inaugurated in June, 1923, for the purpose of educating San Franciscans with regard to the Hetch Hetchy construction. These excursions have been quite well patronized and have been of great value in awakening the public to a realization of what the Hetch Hetchy project is and what it means for the future of San Francisco. The excursions are run on a non-profit basis, the cost being set at $29.50 including an upper berth, or $31.00 with a lower berth, this charge including all costs such as transportation, Pullman, lodging, meals,

etc. A member of the City's engineering force accompanies the party to give explanations of the work and its problems. On these trips, the passengers leave San Francisco late Friday evening, traveling by Pullman cars, over either the Southern Pacific or Santa Fe Railway and the Sierra Railway to Hetch Hetchy Junction where they are transferred to the day equipment of the Hetch Hetchy Railroad. Saturday and Sunday are spent visiting the principal points of interest on the aqueduct and dam construction. Saturday night is spent at Hetch Hetchy Lodge of the Yosemite National Park Company at Mather, and on Sunday evening the party returns to the Pullman cars at Hetch Hetchy Junction and arrives at San Francisco early Monday morning.

United States Mail:

Mail service has been maintained as in previous years. On the completion of the O'Shaughnessy Dam and the abandonment of the camp at Hetch Hetchy, the post office there was closed and mail service discontinued.

Ballasting:

The ballasting program that had been carried on in connection with the ordinary maintenance work during the early part of the year, was pushed to completion during the months from January to April, 1923, in order to open to our rod engines those sections of track from which they had been excluded during the wet weather. Practically the entire road is now ballasted with crushed rock or gravel, and maintenance requirements reduced to a minimum.

Winter Conditions:

Although the winter of 1922-23 was as severe as generally experienced, very little trouble was encountered in maintaining traffic. Improved roadbed and equipment made it much easier to keep traffic moving, and owing to the stabilizing effect of previous seasons, no slides of any consequence occurred.

New Construction:

The new bridge at Sixbit Gulch, described elsewhere in this report, has been completed and put in service.

Fill protection along the Tuolumne River, necessitated by the filling of the Don Pedro reservoir, is being done by the Modesto and Turlock Irrigation Districts.

Additional yard tracks have been installed at Moccasin to handle material and machinery for the Moccasin Creek power house.

At Cavagnaro Siding, additional trackage has been provided for handling material for the pipe lines, etc. Excavation for the penstocks necessitated the construction of a trestle to carry the railroad over the line at the crossing.

A new siding was constructed in Mile 6 to serve the camp at Red Mountain Bar.

Rolling Stock:

During most of the year the railroad owned and operated six locomotives. Extensive repairs on locomotive No. 4 necessitated renting a Shay locomotive from the Northwestern Pacific Railroad for a few months. After the completion of the O'Shaughnessy Dam, the two Heisler locomotives Nos. 1 and 2 were sold, leaving four locomotives in service. Some changes have been made in the gasoline motor equipment. Most notable of these was the reconstruction of a White passenger car. The car was rebuilt with a low center of gravity and with the engine in the rear end. It has proved highly successful.

Following is a list of equipment utilized in connection with the operation of the road:

Hetch Hetchy Railroad Rolling Stock

Locomotives

No.	Make	Type	Weight	Year of Purchase
3	Baldwin	Mikado (2-8-2)	83 tons	1917
4	American	" (2-8-2S)	92 "	1919
5	"	Prairie (2-6-2S)	64 "	1921
6	Shay	12 Wheels, geared	101 "	1922

Passenger Train Cars

Passenger coaches, 44 ft. 11 in. long, seating 52	2
Excursion observation coaches, 39 ft. 6 in. long, seating capacity 77	2
Combination passenger and baggage coach, 58 ft. long, seating capacity 40	1
Total passenger cars	5

Freight Train Cars

Class	Length Feet	Weight Pounds	Capacity Pounds	Number Owned	
Flat cars	34	22,000	60,000	6	
" "	40	24,500	60,000	4	
" "	40	29,000	80,000	1	
" "	41	33,000	100,000	3	
Total flat cars					14
Box cars	33	25,000	40,000	6	
" "	35	26,000	40,000	1	
" "	35	28,000	50,000	1	
" "	36	32,000	60,000	4	
Total box cars					12
Gondola cars, center dump	39	32,900 to 37,400	80,000	8	
Gondola cars, side dump	39½	68,500	100,000	2	
Side dump cars	27	29,400	12 cu. yds.	4	
Total gondola and dump cars					14
Caboose cars	24	20,000	30,000	2	2
Total freight train cars					42

Railroad Service Cars

Class	Length Feet	Weight Pounds	Capacity Pounds	Number Owned
Steam shovel		80,000		1
Snow plow	30	60,000		1
Tank car	34	20,000	40,000	1
Total railroad service cars				3

Gasoline Motor Equipment

Class of Service	Make	Capacity Passengers	Capacity Tons	Number Owned
Passenger	White	13	¾	1
"	"	27	2	1
"	"	25	2	1
"	"	32	2	1
"	Pierce Arrow	16	2	1
Railroad service fire patrol	Pierce Arrow			1
Total motor cars				6
Motor-driven section cars (speeders)				9

The gondola and dump cars are used in hauling gravel and crushed rock for ballasting the railroad track, and will also be used to transport sand and crushed rock for tunnel lining and other concrete work. They may therefore be considered either as freight train cars or as railroad service cars. The tank car is used in connection with steam shovel operation, to supply oil and water to the shovel. It is a flat car on which have been mounted two steel tanks having capacities for 2325 gallons of water and 1800 gallons of oil, respectively.

Munn Sand Plant.

This plant, located on the Tuolumne River at Munn Station, has been in continuous operation. The capacity has been doubled by installing a second log washer, and the output has been further augmented by saving the gravel rejected by the screens. This gravel was used for concreting the Red Mountain Bar siphon and is now being hauled to Moccasin Creek for foundation work on the power house.

The sand was hauled to Priest Dam for the core wall, to Red Mountain Bar for the pipe covering, and is now being hauled to Moccasin Creek and Cavagnaro for the power house and penstock piers.

Mather Sawmill.

At the City's sawmill at Mather, lumber is sawed and, if required, surfaced for camp buildings, concrete forms, tunnel timbers, etc., on the project. The capacity of the mill has been increased to 30,000 board feet per eight-hour shift. The log chute begun in April, 1922, has been extended during the fiscal year. The mill was operated for nine months of the year, being shut down from January 17 until April 18, on account of snow.

The total output of the City's mill including lumber sawed at the former mill site at Canyon Ranch, has been as follows:

	Board Feet
Canyon Ranch	6,321,816
Mather, to June 30, 1922	8,223,838
Total to June 30, 1922	14,545,654
Mather, July 1, 1922, to June 30, 1923	5,989,021
Total to June 30, 1923	20,534,675

Road Work.

The City continued co-operation with the State in maintaining the Big Oak Flat road east of Groveland, contributing several carloads of crushed rock from the Big Creek crusher. The State hauled and distributed this material by truck. The road was thus kept passable for automobiles during the winter months.

The usual work was done to keep the roads to the various camps in condition for hauling.

The existing road from South Fork to Mather has been maintained in accordance with the Hetch Hetchy grant.

Lower Cherry River Power Development.

During the year the 3000 kv.-a power plant of the Lower Cherry River Power Development, at Early Intake, has supplied power for construction uses on the City's work, and also surplus power which has been sold to the Pacific Gas and Electric Company. The output of the plant for the year was 25,622,500 kw.-h.

The standby tie near Moccasin Creek power plant, between the Lower Cherry transmission line and the Pacific Gas and Electric Company's 60,000 K. V. line from Don Pedro, was completed and placed in readiness to serve in September, 1922. Fortunately, heavy rains, during the late fall and early winter, replenished the water supply tributary to the Lower Cherry diversion and made it unnecessary to buy power for the construction work, to assist in carrying the City's power system over a low water period.

In February and March, 1923, the operation of the Lower Cherry plant was interrupted, due to a break in the aqueduct near the penstock pipe, caused by a landslide.

The water supply to the power plant was cut off from February 26 to March 14, during which time the entire Hetch Hetchy work was carried on as usual with power furnished by the Pacific Gas and Electric Company's system over the tie connection.

From July 1, 1922, to June 30, 1923, the power handled by the system was as follows:

Statistics of Operation of Lower Cherry River Power System.

Generated at Lower Cherry plant	25,622,500 k.w.h.
Metered in from P. G. & E. Co. at Priest	382,000 k.w.h.
Metered in from P. G. & E. Co. at Moccasin Creek	841,860 k.w.h.
Total	26,846,360 k.w.h.
Metered out to P. G. & E. at Priest	4,841,000 k.w.h.
Metered out to P. G. & E. at Moccasin Creek	1,920 k.w.h.
Metered out to Utah Const. Co. at O'Shaughnessy Dam	1,181,696 k.w.h.
Used by the City (including Contract 77-C)	14,379,253 k.w.h.
Metered out to Miscellaneous consumers	10,070 k.w.h.
Transmission losses and unaccounted for	6,432,421 k.w.h.
Total	26,846,360 k.w.h.

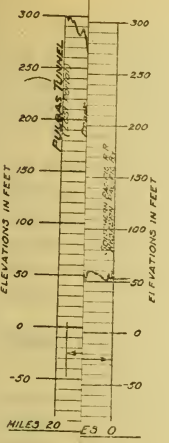
San Joaquin Division Rights of Way.

For a distance of 34.9 miles in the San Joaquin Valley, the Hetch Hetchy transmission line and aqueduct will follow the same route. To provide for the immediate construction of the transmission line, a right of way in fee is being purchased over this distance. The strip is 110 feet wide, and extends from a point near Oakdale, Stanislaus County, to a point near Vernalis in San Joaquin County. It will include about 3000 acres.

Bay Development.

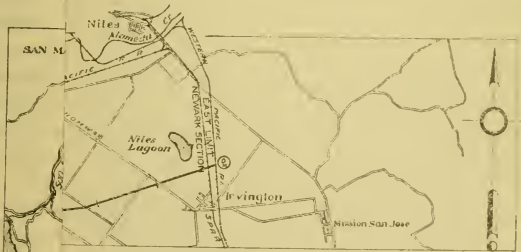
Bay Crossing Pipe Line:

Surveys have been completed for the location of the bay crossing pipe line, from Newark to Pulgas Tunnel. A right of way in fee, 60 to 100 feet wide, with some wider portions for pump station, pipe yards, etc., is being acquired. A large part of the land has been purchased, and condemnation proceedings for the acquisition of the remainder are under way.



LOCALITY MAP

Scale of Miles 1 0 1



HETCH HETCHY WATER SUPPLY
OF THE CITY AND COUNTY OF
SAN FRANCISCO, CALIFORNIA.

MAIN AQUEDUCT - BAY CROSSING DIVISION

BAY CROSSING PIPE LINE

FROM IRVINGTON TO PULGAS TUNNEL

GENERAL MAP AND CONDENSED PROFILE.

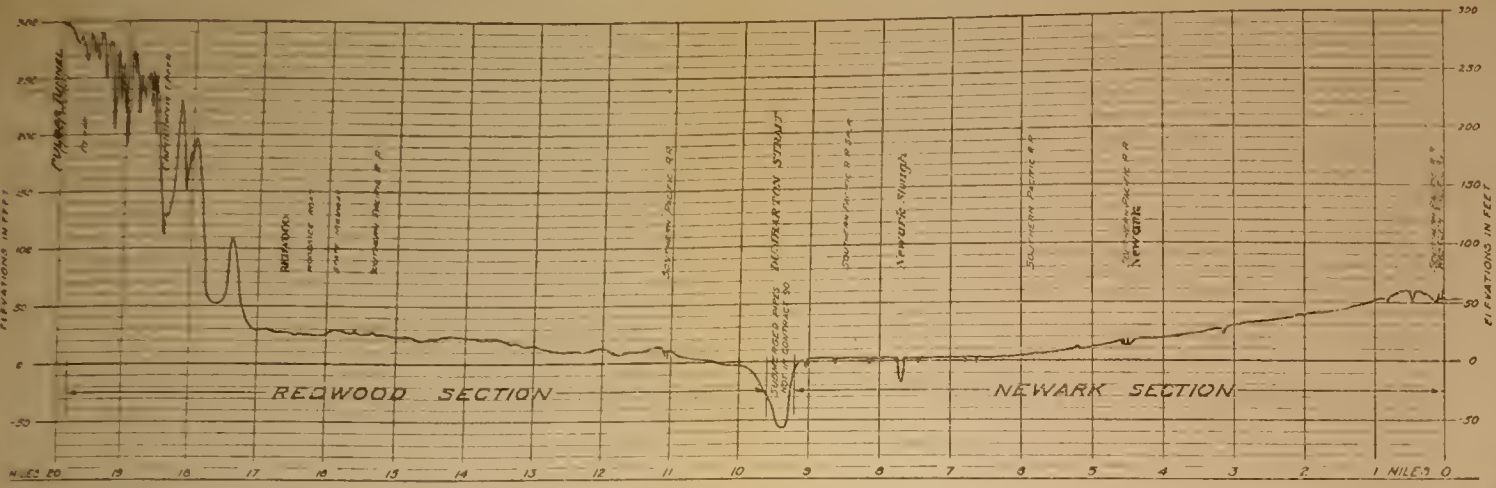
DEPARTMENT OF PUBLIC WORKS

APPROVED M.M. O'Shaughnessy CITY ENGINEER.
April 7, 1923

BY E.H.M.S. TRACED E.J. CHECKED E.J.
SCALE As shown DATE March 1923

C-398

Scale of Miles: 0 1 2



HETCH HETCHY WATER SUPPLY
OF THE CITY AND COUNTY OF
SAN FRANCISCO, CALIFORNIA

MAIN AQUEDUCT - BAY CROSSING DIVISION

BAY CROSSING PIPE LINE

FROM IRVINGTON TO PULGAS TUNNEL

GENERAL MAP AND CONDENSED PROFILE

DEPARTMENT OF PUBLIC WORKS

APPROVED M. M. O'Shaughnessy CITY ENGINEER

BY ... TRACED ... CHECKED ...

SCALE ... DATE ...

C-398

The contract for the construction of the pipe line was let to the Western Pipe and Steel Company of California, as previously stated. It is expected that actual installation of pipe will begin about September 15, 1923.

A steel bridge is contemplated to carry the pipe over the shallow portion of Dumbarton Strait. In order to obtain information regarding the nature of the bottom, the City has had a test pile driven on the site of each prospective bridge pier. This work was done by the Healy-Tibbitts Construction Company under Contract No. 92, for about $5000, and was completed in June, 1923.

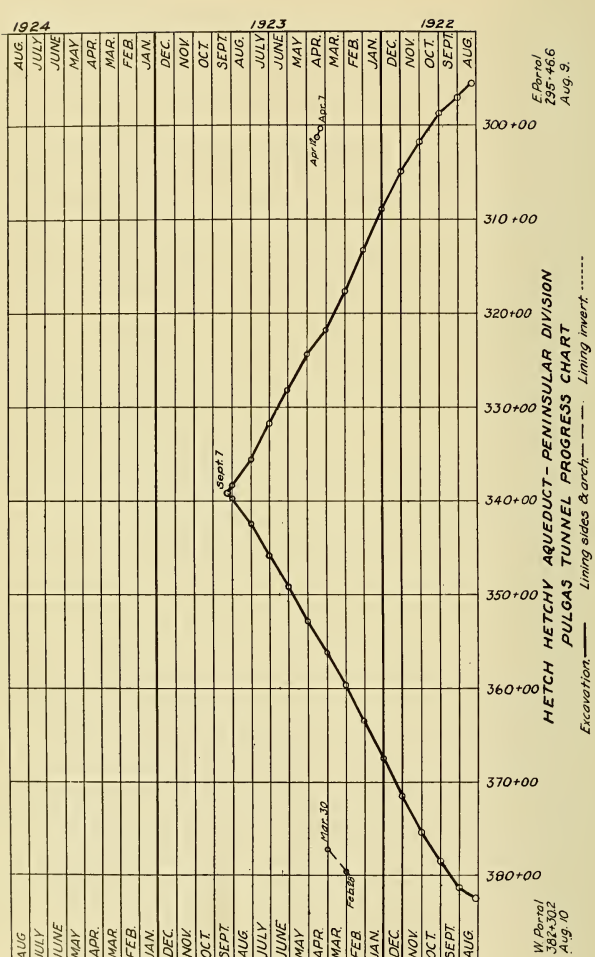
Pulgas Tunnel:

Pulgas Tunnel, which forms the westerly end of the aqueduct from Irvington to Crystal Springs, is being constructed by Grant Smith & Company. Work on camps and plants was begun on July 3, 1922; the east heading was opened on August 9, and the west heading on August 10. Tunneling from both portals began through diabase, passed through a contact zone of tough clay, and continued in Chico sandstone. Almost the entire length so far excavated has required timbering. 7274 feet of tunnel, or 83.7% of the entire length of 8684 feet, has been excavated to date.

Concrete lining of sides and arch began in the east tunnel on February 28, and in the west on April 27. After lining about 350 feet of the tunnel, it was seen that the work could be done to much better advantage after completion of the excavation, and as there is ample time to complete the tunnel, the contractor was permitted to discontinue lining until after holing through. The last work of lining was done in the east heading on March 30, and in the west on April 12. Lining will be resumed after the completion of the excavation, which is expected in September, 1924.

Fifteen hundred lineal feet of open cut excavation at the approaches has been completed.

Progress in excavation and lining of Pulgas Tunnel is illustrated graphically by the chart on the following page.


1924
1923
1922
AUG.
JULY
JUNE
MAY
APR.
MAR.
FEB.
JAN.
DEC.
NOV.
OCT.
SEPT.
AUG.
300+00
310+00
320+00
330+00
340+00
350+00
360+00
370+00
380+00
Sept. 7
Apr. 10
Apr. 1
Mar. 30
Feb. 8
W. Portal
382+30.2
Aug. 10
E. Portal
295+46.6
Aug. 9
HETCH HETCHY AQUEDUCT - PENINSULAR DIVISION
PULGAS TUNNEL PROGRESS CHART
Excavation. ——— Lining sides & arch. — — — Lining invert. ------

Expenditures on Hetch Hetchy Project for Fiscal Year Ended June 30, 1923.

Water Construction

Acct. No.	Primary Accounts	Amount
	General Expenditures	
2002	Land, water rights and rights of way	$ 10,880.59
2003	Rentals, U. S. Government	15,000.00
2004	Legal expenses	10,043.94
2005	Hydrography	3,434.12
2006	City Office administration	42,384.76
2007	" " engineering	72,512.33
2008	State compensation insurance fund	*1,625.45*
2009	Taxes	6,515.91
2010	Miscellaneous construction expenditures	18,683.83
2012	Unamortized discount on securities	1,248.65
2101	Groveland office administration	51,341.84
2102	" hospital buildings and equipment	31,682.62
2104	" " operating expenses	40,812.66
2110	" dwellings	8,745.43
2111	" warehouse	1,214.53
2112	" permanent water supply	4,075.66
2114	" stable and garage equipment	2,305.68
	Total	$ 319,257.10
	Hetch Hetchy Division	
2202	Engineering	30,229.85
2203	Camps	2,868.28
2204	Roads, trails and tramways	1,943.05
2205	Dam and appurtenances	36,763.94
2205	" " " Utah Construction Contract No. 61	2,713,172.60
2206	Clearing reservoir	46,596.24
2226	Telephone Lines	49.33
2227	Camp Maintenance	98.63
	Total	$ 2,831,721.92
	Tunnel Construction	
2402	Engineering	36,630.48
2404	Roads, trails and tramways	1,802.01
2406	Shafts	23.88
2407	Construction (City forces)	12,180.28
2407	" (Construction Co. of North America, Contract No. 77C)	2,287,902.84
2426	Telephone lines	21.00
2427	Camp maintenance	823.24
	Total	$ 2,339,383.73

Italics indicate Credit.

Expenditures on Hetch Hetchy Project

Water Construction (Cont.)

Acct. No.	Primary Accounts	Amount
	Foothill Division	
2702	Engineering	$ 4.00
2708	Tuolumne River Crossing	260,856.60
	Total	$ 260,860.60
	Early Intake Diversion Works	
2901	Preliminary surveys and investigations	228.12
2902	Engineering	510.33
2903	Camps	1,000.50
2904	Roads, trails and tramways	2,459.82
2905	Dams and appurtenances	69,030.65
2906	Spillway	16,009.75
2907	Tunnel construction	15.96
	Total	$ 89,255.13
	Mather Sawmill	
3002	Engineering	24.21
3003	Camps	127.72
3004	Roads, trails and tramways	81.75
3005	Sawmill and equipment	*50.00*
3006	" stumpage rights and lands	*700.00*
3027	Camp maintenance	779.60
3070	Operating expenses	107,787.43
	Total	$ 108,050.71
	Munn Sand Pit	
3101	Plant and equipment	2,170.09
3170	Operating expenses	28,623.03
	Total	$ 30,793.12
	San Joaquin Division	
3305	Lands and rights of way	52,063.82
	Golden Rock Ditch	
3501	Operating expenses	816.31
	Boarding and Commissary Expense	
4000	Boarding houses (City forces)	342,172.47
4500	Commissary supplies	*2,280.83*
4510	" expenses	*6,655.79*
	Total	$ 333,235.85

Italics indicate Credit.

Expenditures on Hetch Hetchy Project

Water Construction (Cont.)

Acct. No.	Primary Accounts		Amount
5000	Materials and Supplies	Expenditures $1,539,364.48	
5010	M. and S. Misc. Construction expenditures	Disbursements.... 1,556,196.02	*16,831.54*

Bay Development

6001	General engineering	3,320.36
6002	" lands and rights of way.....	110,766.62
6007	" City office administration and engineering	8,109.35
6101	Newark Division preliminary surveys and investigations	407.30
6102	Newark Division Engineering	1,274.21
6201	Ravenswood Division Preliminary surveys and investigations	760.42
6202	Ravenswood Division Engineering	492.06
6207	Ravenswood Division Test Piles Dumbarton Straits Contract No. 92	3,777.20
6302	Redwood Division Engineering	1,560.43
6401	Peninsular Division Preliminary surveys and investigations	2,163.17
6402	Peninsular Division Engineering	8,240.37
6407	Peninsular Division Tunnel Construction, Grant-Smith Contract No. 85.....	333,400.64
	Total.....	$ 474,272.13
	Total Gross Expenditures Water.....	$ 6,822,878.88

Under the terms of Contract No. 77C (Acct. No. 2407) the Contractor is charged for all material and power furnished and for all services rendered by the City. The charges for such services are included as expenditures as herein set forth against the Contract and deducted as listed below, as such charges are not covered directly by actual cash expenditures:

Difference in Hospital dues collected....$	*5,808.19*	
Lumber furnished	*8,742.55*	
Power "	*118,292.76*	
Transportation of employees.....	*5,763.75*	
Transportation of materials and supplies	*21,391.11*	*159,998.36*
Total Net Water Expenditures.....		6,662,880.52
Transfer amount deducted from Refunds, Sales, etc., 1921		2,488.55
Total Water Expenditures Year Ended June 30, 1923		$ 6,665,369.07

Italics indicate Credit.

Expenditures on Hetch Hetchy Project

Power Construction

Acct. No.	Primary Accounts	Amount
	Lake Eleanor Division	
2303	Camps	$ 6.90
2304	Roads, trails and tramways	3,758.94
2305	Dam and appurtenances	92.30
2306	Clearing reservoir	7,922.88
2326	Telephone lines	82.81
	Total	$ 11,863.83
	Priest Division	
2502	Engineering	13,016.53
2503	Camps	6,208.44
2504	Roads, trails and tramways	4,723.61
2505	Dam and appurtenances	435,872.65
2506	Clearing reservoir	740.73
2507	Outlet or power tunnel	319,550.23
2508	Diversion tunnel	14,214.54
2526	Telephone lines	140.06
2527	Camp maintenance	5,346.49
	Total	$ 799,813.28
	Moccasin Creek Division	
2602	Engineering	16,645.86
2603	Camps	38,010.03
2604	Roads, trails and tramways	9,242.06
2605	Lands for electrical purposes	1,655.00
2606	Penstock	121,323.86
2607	Power plant, buildings and structures	49,837.70
2608	Power house, hydraulic equipment, Coffin Valve Co. Contract No. 79	16,059.81
2608	Power house, hydraulic equipment, Pelton Water Wheel Co. Contract No. 79A	149,206.98
2609	Power house, electrical equipment, General Electric Co. Contract No. 80	150,550.97
2609	Power house, electrical equipment, Westinghouse E. & M. Co. Contract No. 81	223,571.81
2613	Power house, miscellaneous equipment	581.43
2626	Telephone lines	89.18
2627	Camp maintenance	3,537.09
2628	General equipment	1,158.60
2691	Concrete store plant	7,641.65
2692	Stable and garage expense	2,366.39
2693	Locomotive crane expense	504.00
2698	Material and supplies	75,940.06
2699	Material and supplies expense	3,739.87
	Total	$ 871,662.35

Expenditures on Hetch Hetchy Project

Power Construction (Cont.)

Acct. No.	Primary Accounts	Amount
	Lower Cherry Power Development	
2802	Engineering	$ 44.51
2803	Camps	12.00
2804	Roads, trails and tramways	9.00
2805	Land for electrical purposes	1,119.20
2814	Transmission Line, poles and fixtures	10,350.37
2815	" " overhead construction	7,581.59
2816	" " clearing	444.89
2817	" " substation and general buildings	432.08
2818	" " substation equipment	3,480.34
2820	" " transformers and devices	18,443.53
2822	Meters	38.75
2827	Camp maintenance	11.52
2870	Operating expenses	136,902.61
	Total	$ 178,870.39
	Power Transmission System	
3201	Preliminary surveys and investigations	9,814.34
3202	Engineering	1,208.57
3205	Land and rights of way	17,255.97
3214	Poles and fixtures	1,576.60
	Total	$ 29,855.48
	Total Power Expenditures for Year Ended June 30, 1923	$ 1,892,065.33

Hetch Hetchy Railroad

Investment Account, Additions and Betterments	$86,755.99	
Investment Account, Materials and Supplies	15,324.47	102,080.46
Operating Expenses		588,497.77
Total Railroad Expenditures		$ 690,578.23

Miscellaneous Credits

During the fiscal year the following amounts have been deposited with the City Treasurer to the General Hetch Hetchy 1910 Bond Fund, and credited herein to the various appropriate accounts, reducing the expenditures:

Material and Supplies	Water	$21,153.43
" " "	Power	2,251.57
" " "	Railroad	3,831.85
Sale of Locomotives (2)	Railroad	25,000.00
State Compensation Insurance Fund		30,092.71
Total Amount Credited to Above Accounts		$82,329.56

Receipts from Operations not Included in the Foregoing Deposited to the General Hetch Hetchy Bond Fund

Acct. No.	Water Construction	Amount
2002	Crocker Amazon Tract Rentals	$ 2,350.80
2002	Mather. Yosemite Nat'l Park Co. Rentals	50.00
2002	Mather. Standard Oil Co. Rentals	100.00
2103	Groveland Hospital Receipts	26,249.69
2109	Groveland Dwellings Rentals	2,259.70
3040	Mather Sawmills Receipts	21,187.06
4000	Boarding Houses Receipts City forces	295,687.02
4000	Boarding Houses Receipts Contractor's forces No. 77C	221,633.95
	Total Receipts—Water Construction	$ 569,518.22
	Power Construction	
	Sale of Power, total receipts	38,459.00
	Railroad Operation	
	Freight revenue	457,233.61
	Passenger revenue	36,660.49
	Mail revenue	4,226.25
	Special train service	412.62
	Miscellaneous receipts	1,129.29
	Total Railroad Receipts	$ 499,662.26
	Interest received on Bay Development expenditures to May 30, 1923	6,627.79
	In addition to the foregoing receipts the Railroad was credited in report to the Railroad Commission for year ended Dec., 1922, with the following non-revenue services or earnings:	
	Water and Power Service $ 142,713.95	
	Railroad Service 6,592.80	149,306.75

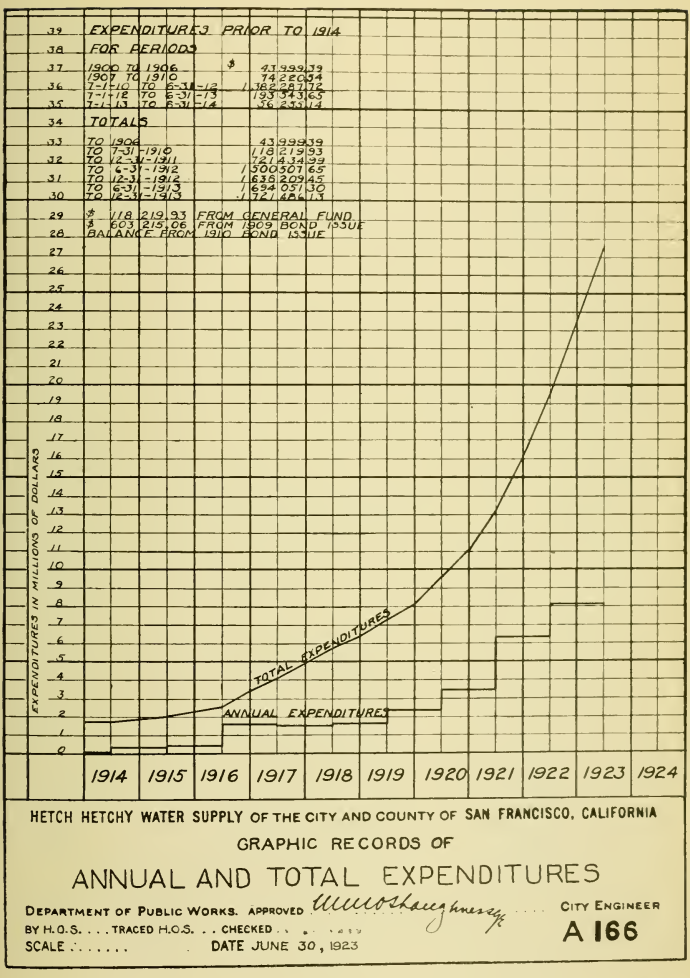
Summary of Expenditures and Receipts

Expenditures

Water Construction	$6,665,369.07	
Power "	1,892,065.33	
Railroad " and operation	690,578.23	$ 9,248,012.63

Receipts

Water Construction	569,518.22	
Power "	38,459.00	
Railroad " and operation	499,662.26	1,107,639.48
Total net expenditures for year 1922-1923		8,140,372.15
" " " prior to July, 1922		19,506,971.54
" " " to July 1, 1923		$27,647,343.69



HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

GRAPHIC RECORDS OF

ANNUAL AND TOTAL EXPENDITURES

DEPARTMENT OF PUBLIC WORKS. APPROVED M. M. O'Shaughnessy CITY ENGINEER

BY H.O.S. . . . TRACED H.O.S. . . CHECKED

SCALE . . . . . DATE JUNE 30, 1923

A 166

Hetch Hetchy 1910 Bond Fund

Statement of Hetch Hetchy 1910 Bond Fund as at June 30, 1923

Treasurer's balance July 18, 1923	$9,530,735.82	
Unsold bonds	5,281,000.00	
Operative revenue fund	825,842.51	
Balance on hand as at June 30, 1923		$15,567,578.33

Contractual Liabilities

Cont. No.	Contractor	Amount Of Contract	Paid	Due
70	Pawling & Harneschferger	$ 31,000.00	$	$ 31,000.00
77C	Const'n Co. of N. America	7,802,952.80	*6,953,572.23	*849,380.57
78C	Anaconda Copper Mining Co.	195,000.00		195,000.00
79	Coffin Valve Co.	37,580.00	16,069.81	21,510.19
79A	Pelton Water Wheel Co.	248,800.00	149,206.98	99,593.02
80	General Electric Co.	260,285.00	150,550.97	109,734.03
81	Westinghouse Electric & Mfg. Co.	379,585.00	161,350.54	218,234.46
82	Union Const'n & Drydock Co.	65,000.00		65,000.00
85	Grant-Smith Co.	700,000.00	333,400.64	366,599.36
89	Aluminum Co. of N. America	375,000.00		375,000.00
90B	Western Pipe & Steel Co.	2,300,000.00		2,300,000.00
91A	Western Pipe & Steel Co.	220,000.00		220,000.00
91G	M. W. Kellogg	1,050,000.00		1,050,000.00
	Amount due on Contracts			$ 5,901,051.63
	Balance available for expenditure			$ 9,636,526.70

*Including credit $614,987.80 per statement rendered Aug. 8, 1923. File Contract 77C.

CONTENTS

	Page
LETTER OF TRANSMITTAL	3
IN MEMORIAM	6
BOULEVARDS, STREETS AND HIGHWAYS	7
SEWERS	31
MISCELLANEOUS CONSTRUCTION:—	
Street Signs	36
Pedestrian Walk	36
Esplanade	36
High Pressure System Extensions	37
PROJECTS AND INVESTIGATIONS:	
Rincon Hill Regrade	38
Sunset Tunnel	39
Golden Gate Heights	41
Ingleside Heights	41
Miscellaneous Activities	42
SURVEYS	44
STREET IMPROVEMENT ASSESSMENTS, ETC.	46
MUNICIPAL RAILWAY:—	
Market Street Railway Purchase	47
Extensions	47
Equipment	50
Car Barns and Shops	51
Lower Market Street	51
Contracts	52
HETCH HETCHY WATER SUPPLY	53
Progress and Developments (Power Disposal Reports)	54
Organization and Headquarters Work	80
O'Shaughnessy Dam	86
Aqueduct Tunnels	96
Early Intake Diversion Works	103
Moccasin Creek Power Development	105
Red Mountain Bar Siphon	117
Sixbit Gulch Bridge	119
Hetch Hetchy Railroad	120
Munn Sand Plant	126
Mather Sawmill	126
Road Work	127
Lower Cherry River Power Development	127
San Joaquin Division Rights of Way	128
Bay Development	128

ILLUSTRATIONS AND DIAGRAMS.

Page

O'SHAUGHNESSY DAM AND HETCH HETCHY RESERVOIR ..... Frontispiece

RECONSTRUCTION OF MARKET STREET 8

MARKET STREET EXTENSION, MONO STREET TO TWENTY-FOURTH STREET:—
Before improvement, showing location of road 10
After improvement 11

SLOAT BOULEVARD—Showing completed pavement 13

TELEGRAPH HILL BOULEVARD—Parking circle at top of Telegraph Hill 14

LINCOLN PARK BOULEVARD—Grading for highway adjacent to Municipal Golf Links 16

LIBERTY STREET, LOOKING WEST FROM CHURCH ST.:
Before improvement 18
After grading and construction of walls 19

LOMBARD STREET, LEAVENWORTH STREET TO HYDE STREET 21

ARMY STREET SEWER EXTENSION:—
Showing concrete invert and reinforcement for walls and arch 8 ft. 6 in. by 10 ft. 6 in. basket-shaped and 8 ft. by 10 ft. flat-top reinforced concrete sewer 32 33

COSTS OF LABOR AND MATERIALS AND NUMBER OF MEN EMPLOYED, HETCH HETCHY WATER SUPPLY—(Graphic Record) 84

O'SHAUGNESSY DAM:—
Downstream face with siphon spillway in action 87
Progress Chart of Concrete Placing ..... opposite 88
3-foot Needle Valves on downstream face 92
Showing stepped construction of downstream face and jets from two 5-foot outlet valves 94

AQUEDUCT TUNNELS, MOUNTAIN DIVISION, HETCH HETCHY WATER SUPPLY PROJECT:—
Progress Profile Chart ..... opposite 96
Concrete lining of sides and arch and collapsible forms in place 102

PRIEST DAM, MOCCASIN CREEK POWER DEVELOPMENT.
Upstream face, showing riprap paving and gate tower 106

MOCCASIN CREEK POWER PLANT:
Site of power plant showing excavation for power house and penstocks 109
Equipment, showing runners for impulse waterwheels and transformers 111
Moccasin Creek Power House (from drawing of proposed structure) 114
Construction view, showing discharge outlets to tailrace and structural steel frame 116

RED MOUNTAIN BAR SIPHON, HETCH HETCHY AQUEDUCT 118

ILLUSTRATIONS AND DIAGRAMS—(Continued)

Page

PLATE GIRDER BRIDGE—At Sixbit Gulch on Hetch Hetchy Railroad 121

BAY CROSSING PIPE LINE FROM IRVINGTON TO PULGAS TUNNEL, HETCH HETCHY WATER SUPPLY—General Map and Condensed Profile ..... opposite 128

PULGAS TUNNEL, PENINSULA DIVISION, HETCH HETCHY WATER SUPPLY—Progress Chart 130

ANNUAL AND TOTAL EXPENDITURES, HETCH HETCHY WATER SUPPLY (Graphic Record) 137

TABLES.

	Page
STREET WORK PERFORMED UNDER CONTRACTS	29
DEPOSITS RECEIVED FOR SIDESEWERS	34
SURVEYS PERFORMED	44
PRECISE LEVELS AND BENCH MARKS	44
MAPS APPROVED AND FILED	44
FEES RECEIVED FOR SURVEYS AND INSPECTION	45
ASSESSMENTS AND BONDS FOR STREET WORK	46
STREET WORK PROCEEDINGS	46
NOTICES, PERMITS AND INVESTIGATIONS	46
PERMITS AND FEES FOR CORPORATION TRENCHES	46
CURRENT CONTRACT DATA—Boulevards, Sewers, Municipal Railways	opposite 52
ESTIMATES FOR DETERMINATION OF COST OF POWER:—	
Plant valuation	59
Operating and fixed charges	59
CURRENT PURCHASED BY PACIFIC GAS AND ELECTRIC COMPANY DURING 1921	60
DISTRIBUTION AND USES OF POWER SOLD IN SAN FRANCISCO DURING 1921	62
ESTIMATED POWER DEVELOPMENT, HETCH HETCHY WATER SUPPLY	71
DISTRIBUTION IN SAN FRANCISCO BY POWER COMPANIES, 1922	72
ESTIMATED FUTURE GROWTH AND DEMAND FOR POWER	73
ESTIMATE OF COST OF A COMPLETE DISTRIBUTION AND STAND-BY SYSTEM	77
RECORD OF BIDS RECEIVED:—	
Contract 90, Bay Crossing Pipe Line	opposite 80
Contract 91, Steel Penstocks and Accessories	opposite 80
O'SHAUGHNESSY DAM—QUANTITY OF CONCRETE PLACED EACH MONTH	89
AQUEDUCT TUNNELS, MOUNTAIN DIVISION, HETCH HETCHY WATER SUPPLY—PROGRESS IN EXCAVATION	97
HETCH HETCHY RAILROAD ROLLING STOCK	124
STATISTICS OF OPERATION OF LOWER CHERRY RIVER POWER SYSTEM, HETCH HETCHY WATER SUPPLY	128
EXPENDITURES ON HETCH HETCHY PROJECT—For fiscal year ending June 30, 1923	131
HETCH HETCHY 1910 BOND FUND—Statement as at June 30, 1923	138
CONTRACT DATA, HETCH HETCHY WATER SUPPLY	Appendix

APPENDIX

CONTRACTS — HETCH HETCHY WATER SUPPLY

Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12	Col 13	Col 13A	Col 14	Col 15	Col 16	Col 17	Final Estimate Contract Items	Final Estimate Extras & Deductions	Final Estimate Amount Paid	Col 21	Col 22
		$ 2,402,450	$ 425,750			$ 2,874,331.42	$ 2,174,874.48	$ 2,185,017.52							$ 2,395,966.60	$ 83,470.92	$ 2,479,437.52		
H	Dam — 60 cu ft of concrete masonry in the main dam, to be placed above foundations at about 300 ft. constructed with a view to future enlargement	H H Reservoir	$ 400,000	400,000	July 30 1919	1	$ 475,910.00	544,739.50	544,739.50	Utah Construction Co	814 Phelan Bldg S F	Aug 1, 1919	Aug 12, 1919	900		5,347,792.50		5,347,792.50		
K	300 ft of 8 ft dia riveted pipe made of 3/8 gage steel & fittings	Aqueduct Tunnels - Mtn Div	5,300	1,000	June 6 1919	1	5,318.40	5,318.40	5,318.40	Western Pipe & Steel Co.	444 Market St S F	June 11 1919	June 26 1919	75	July 31 1919	5,318.40	- 23.60	4,987.40	33	
L	1 set of operating & covering parts	Boarding Houses at permanent camps	6,300	1,800	June 9, 1919	3	10,368.30	5,775.00	5,775.00	Walter S Leland	61 Second St S F.	June 13 1919	July 9 1919	60	Oct 24 1919	5,775.00		5,775.00	97	
L-m	4 Set of dumping skips for shafts	Big Creek Shaft and Second Garrotte Shafts	4,750	1,000	July 2 1918	2	3,312.00	2,929.00	2,929.00	Michel & Pfeffer Iron Works	1415 Harrison St S F	July 9, 1918	July 28 1919	16	Sept 15 1919	2,929.00	- 72.75	2,906.75	49	
M-m	1 Motor Driven Centrifugal Turbine Pump 3600 gals per min	Big Creek Shaft	2,670	800	July 23 1919	4	3,670.00	2,287.50	2,287.50	Worthington Co Inc.	Sharon Bldg. S.F.	July 30 1919	Aug 14 1918	100	Mar. 19 1920	2,287.50		2,287.50	218	
H-H	6 S. de Bates complete with operating mechanism	Hetch Hetchy Dam	120,000	40,000	Mar 3, 1920	4	170,000.00	121,000.00	121,000.00	Coffin Valve Co.	Monadnock Bldg	Mar 5 1920	May 19 1920	Feb 28 1921	Feb 24, 1922	121,000.00	3,724.35	124,724.35	141	
H-H	6 2 use Gates complete with operating mechanism	Hetch Hetchy Dam.	130,000	20,000	June 2 1920	1	170,000.00	170,000.00	170,000.00	Union Machine Co.	934 Brannan St.	June 4, 1920	June 9 1920	June 30 1921	Jan 20, 1922	170,000.00	4,929.82	174,929.82	215	
H	6 Balanced Valves complete with oil operating mechanism	Hetch Hetchy Dam.	135,000	50,000	Mar. 10 1920.	2	189,200.00	173,100.00	173,100.00	Wm Cramp & Sons Ship & Eng Bldg Co	Philadelphia, Penn.	Mar 19 1920	Mar. 24 1920	Feb 28 1921	Nov. 2, 1921	173,100.00	4,080.13	177,180.13	551	
H-H	6 Balanced Valves complete with all operating mechanism	Hetch Hetchy Dam.	75,000	25,000	Mar 31 1920.	1	98,500.00	98,500.00	98,500.00	Wm Cramp & Sons Ship & Eng. Bldg Co.	Philadelphia Penn	Apr 2, 1920.	Apr 14 1920	Feb 28 1921	Apr 27, 1921	98,500.00	7,313.18	105,813.18	392	
Mac	270,000 lb crane, 32 ft lift, 30 ft span	Moccasin Creek Power House	30,475	5,000	Dec 8, 1922	6	36,833.00	24,675.00	30,475.00	Dowling & Harnishfeger Co.	32 Beale St, S F	Dec 14, 1922	Jan 8, 1923	Mar 31, 1923						
M-m	1 Motor Driven Centrifugal Turbine Pump 400 gals per min	Second Garrotte Shaft	1,750	500	July 13 1917	5	2,295.00	1,555.80	1,702.00	Allis-Chalmers Mfg Co	Rialto Bldg S F	July 30, 1918	Aug 7 1919	85	Mar 19 1920	1,702.00		1,702.00	255	
M-m	360 ft of 4' dia riveted pipe made of 3/4 gage steel and fittings	Aqueduct Tunnels Mountain Division	9,000	1,000	Aug 6, 1919	3	9,698.50	8,102.10	8,102.10	Montague Pipe & Steel Co	Hobart Bldg. S F	Aug 11 1919	Aug 15 1919	120	Nov 11, 1919	8,102.10		8,102.10	88	
M-m	5,000 ft 11" Std W.I. Pipe Blk 5,000 - 9" - - - 7,000 - 7" - - - 7,000 - 6" - - -	Aqueduct Tunnels Mountain Division	7,500	2,000	Aug 13, 1919	7	8,128.60	6,678.50	6,678.50	R W Kinney Co	586 Howard St. S F	Aug 15, 1919	Sept 10 1919	15	Sept 11 1919	6,678.50		6,678.50	27	
R R	12,800 Tie Plates for 60 lb rails of the "Horriman" type	Hetch Hetchy Railroad	5,500	1,000	Oct 1, 1919	2	5,758.50	4,625.50	4,625.50	United States Steel Products Co	Rialto Bldg. S F	Oct 6 1919	Oct 21, 1919	10	May 6, 1920.	4,496.63		4,496.63	196	
R R	Track Ballast	H H R R between Middle Fork trestle and Big Creek Camp.	6,000	1,000	Oct. 6, 1919	2	6,000.00	6,000.00	6,000.00	W H London	San Francisco	Oct 10, 1919	Oct 16, 1919	90	Dec 17, 1919	3,428.13	- 32.04	2,899.09	63	
M-m	3005 ft of 24" dia riveted pipe made of 3/8 gage steel 300 inch bands made of 3/8 gage steel	Aqueduct Tunnels - Mtn Div	10,500	1,500	Jan 28 1920.	1	12,431.10	12,431.10	12,431.10	Montague Pipe & Steel Co.	Hobart Bldg. S.F.	Jan 30 1920	Feb 6, 1920.	155	Jan 25, 1922	12,431.10	12,352.40	24,783.50	353	
Mac	Concrete lined tunnel 10'-3" x 10' 3" horse shoe section 18 kms long	Early Intake to Priest Reservoir	7,654,000	100,000	Apr 21, 1920	2	8,952,580.00	7,802,952.80	7,802,952.80	Construction Co of North America	431 Mills Bldg S.F.	May 3, 1920	Mar 3, 1920	1000		6,953,572.23		6,953,572.23		
	700 miles of transmission line cable	Hetch Hetchy Transmission line	191,329	40,000	Jan 10, 1923	2	494,242.00	191,328.80	191,328.80	Anaconda Copper Mining Co	Chicago	Jan 15, 1923	Jan 31, 1923	Jan 7, 1924						
Mac	Four 25000 H P impulse water wheel units	Moccasin Creek Power Plant	400,000	100,000	Apr 12, 1922	2	267,000.00	248,000.00	248,000.00	Pelton Water Wheel Co	19th & Harrison Sts., S F	Apr 28, 1922	May 5, 1922	Aug 31, 1923						
Mac	Eight Gate Valves operated by Hydraulic Cylinders	Moccasin Creek Power Plant.		10,000	Apr 12, 1922	9	116,240.00	37,580.00	37,580.00	Coffin Valve Co.	Monadnock Bldg SF	Apr 28, 1922	May 5, 1922	Feb 23, 1923						
Mac	Four 11,000 K.V.A. Generators and one Motor-generator Exciter Set	Moccasin Creek	400,000	100,000	Apr. 12, 1922	3	304,635.00	260,265.00	260,265.00	General Electric Co	Rialto Bldg, S.F.	May 1, 1922	May 11, 1922	Aug 31, 1923						
		$ 15,398,370	$ 1,282,350			$ 23,682,716.80	$ 20,589,033.40	$ 16,589,239.60							$ 12,973.43	$ -114,861.24 - 1061.39	$ 12,516,972.03		
		Does not include contracts not awarded				Does not include contracts not awarded									Includes payments on uncompleted contracts				

* Contracts 1 to 80, inclusive, (sheets 1, 2, and 3) completed and included in Annual Report of Bureau of Engineering for 1921 - 1922

CONTRACTS — HETCH HETCHY WATER SUPPLY

[illegible] OF CONTRACT	DIVISION TO WHICH CHARGEABLE	GENERAL DESCRIPTION	LOCATION OF WORK, OR LOCATION FOR WHICH MATERIAL, ETC. WAS PURCHASED	ENGINEER'S ESTIMATE OF COST	AMOUNT OF BOND FOR FAITHFUL PERFORMANCE	DATE OF OPENING BIDS	NO. OF BIDS	HIGHEST BID	LOWEST BID	SUCCESSFUL BID	CONTRACTOR	CONTRACTOR'S ADDRESS	DATE OF AWARD	DATE OF SIGNING CONTRACT	TIME ALLOWED IN DAYS	DATE OF ACCEPTANCE	FINAL ESTIMATE: CONTRACT ITEMS	FINAL ESTIMATE: EXTRAS & DEDUCTIONS	FINAL ESTIMATE: AMOUNT PAID	CLAIMED BY CONTRACTOR	REMARKS	SHEET NO.
[illegible]	Col 3	Col 4	Col 5	Col 6	Col 7	Col. 8.	Col 9	Col. 10.	Col. 11.	Col. 12.	Col. 13.	Col 13A	Col 14	Col 15.	Col 16	Col 17	Col 18	Col 19	Col 20	Col 21	Col 22	
[illegible] PER AMOUNT FROM SHEET																	$15,412,913.49	$102,326.30	$15,529,913.03			
[illegible]	Mt. [illegible]	15-6667 K.V.A. transformers, 16 station service transformers, switchgear, and instruments	Moccasin Creek Power Plant.	$ 500,000	$135,000.00	Aug 9, 1922	2	$431,622.00	$379,585.00	$379,585.00	Westinghouse Electric and Manufacturing Co	East Pittsburgh, Pa. 1st Nat'l Bank Bldg, S.F.	Aug. 18, 1922	Sept 13, 1922	352							
[illegible]	Mt. [illegible]	880,000 pounds of structural steel	Moccasin Creek Power Plant	60,720	16,000.00	Feb 21, 1923		64,240.00	60,720.00	60,720.00	Union Construction and Drydock Co.	Key Route Basin Oakland, Cal.	Feb. 23, 1923	Mar 10, 1923	121							
[illegible]	Mountain	Ten steel single side dump cars for muck hauling	Mountain Division tunnels.	3,640	500.00	Mar. 23, 1921	7	3,810.00	3,430.00	3,430.00	Joshua Hendy Iron Works.	75 Fremont St	Apr 6, 1921	Apr 9, 1921	76	June 24, 1921	$ 3,490.00	+ $150.00	$3640.00	76		83
84	Mountain	103 4 ft of 84" steel pipe, and 550 cinch bands for same.	Mountain Division tunnels	35,984	2,500.00	Feb 2, 1921	2	17,298.36	16,726.06	16,726.06	Western Pipe and Steel Co of California.	444 Market St. S.F.	Feb 7, 1921	Mar. 10, 1921	120							84
[illegible]	Pe[illegible] -sular	Concrete lined tunnel 4.6 miles long and 10'3" in height and width	Through Pulgas Ridge in San Mateo County	760,000	137,000.00	June 21, 1922	4	779,310.00	683,050.00	683,050.00	Grant Smith and Co.	708 Balboa Bldg S.F.	June 23, 1922	July 5, 1922	500							85
86	H.H.R.R.	Single track plate girder railroad bridge of 9 spans	Sixbit Gulch [Don Pedro Reservoir]	32,500	7,250.00	July 26, 1922	5	37,247.50	26,132.00	26,132.00	Union Construction and Drydock Co.	Key Route Basin Oakland, Cal.	July 28, 1922	Aug 12, 1922	130						Work of contracts 86, 87 and 88 made necessary by raising level of Don Pedro Reservoir	86
87	H.H.R.R.	2 concrete abutments and 8 concrete piers	Sixbit Gulch [Don Pedro Reservoir]	28,300	8,750.00	July 26, 1922	5	44,850.00	32,340.00	32,340.00	Schultz Construction Co.	Geary & Polk Sts. S.F.	July 28, 1922	Aug 12, 1922	105	Oct. 30, 1922	36,374.39	+ 209.17	36,583.56	79	All but $6300 of the cost of this work is to be paid by Turlock and Modesto Irrigation districts	87
88	H.H.R.R.	Grading about 1200 ft of single track roadbed	Sixbit Gulch [Don Pedro Reservoir]	10,000	2,100.00	July 26, 1922	6	13,660.00	7,900.00	7,900.00	M. J. Lyons	512-514 Mission St, S.F.	July 28, 1922	July 31, 1922	60	Mar 16, 1923	8377.70		8377.70	228		88
[illegible]		Furnishing & delivering steel reinforced aluminum cable for the Moccasin Creek Power Plant																				89
90	Bay Crossing	5 foot rivetea steel pipe line, 19½ miles long, 5/16" to 7/16" plate.	Irvington, Alameda Co. to Pulgas Tunnel.	2,700,000	446,332.25	May 16, 1923	3	3,510,305.00	2,231,661.25	2,231,661.25	Western Pipe and Steel Co of California	444 Market St. S.F.	May 18, 1923	June 2, 1923	620							90
91	Moccasin	Penstocks one mile long for 8-12500 H.P. water wheels.	Moccasin Creek Power Plant.	I - 213,017 II-1,016,525	42,600.00 203,305.00	May 23, 1923	5	I-214,341.25 II-1,016,525.00	213,016.70 1,016,525.00	213,016.70 1,016,525.00	I.-Western Pipe & Steel Co. II-M.W. Kellogg Co.	444 Market St, S.F. 90 West St, N.Y.	May 28, 1923	I-June 2, 1923	I-220 II-230						I = Upper portion. II = Lower portion	91
[illegible]	Bay Crossing	Driving test piles at locations of piers for Dumbarton pipe bridge	Dumbarton Strait	3,811	1000.00	May 9, 1923	5	8,939.00	3,811.00	3,811.00	Healy, Tibbitts Construction Co	64 Pine St S.F.	May 14, 1923	June 5, 1923	60	June 19, 1923	3,217.20		3,217.20	14		92
[illegible]				$21,359,038	$2,432,491.25			$25,617,193.69	$21,855,466.15	$21,881,556.39							$15,484,642.76 Includes	$ -115 221 01 - 1026.30 payments uncompleted	$15,569,000.00 on contracts			

EXPLANATION OF ABBREVIATIONS IN COL.

Report of the Bureau *of* Engineering

1923 - 1924

Department of Public Works
City and County of
San Francisco

M. M. O'SHAUGHNESSY
City Engineer

REPORT

OF THE

BUREAU *of* ENGINEERING

OF THE

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF
SAN FRANCISCO

FISCAL YEAR ENDING JUNE 30, 1924

JAMES ROLPH, Jr. - - - *Mayor*

TIMOTHY A. REARDON
DANIEL G. FRASER
CHARLES E. STANTON
Board of Public Works

M. M. O'SHAUGHNESSY
City Engineer

Compliments of
M. M. O'Shaughnessy,
City Engineer.

DEDICATION OF O'SHAUGHNESSY DAM
HETCH HETCHY WATER SUPPLY PROJECT.

JAMES ROLPH, JR., Mayor of the City and County
of San Francisco,
and
M. M. O'SHAUGHNESSY, City Engineer,

Before the name plate on O'Shaughnessy Dam during
dedication ceremonies, July 7, 1923.

Report of the Bureau of Engineering

DEPARTMENT OF PUBLIC WORKS

CITY AND COUNTY OF SAN FRANCISCO

1923-1924

To the Honorable
Board of Public Works of the
City and County of San Francisco.

Gentlemen:—

I transmit herewith the annual report of the Bureau of Engineering for the fiscal year 1923-1924.

In addition to preparation of plans and supervision of construction of pavements, sewers, municipal railway extensions, water supply systems and other engineering works, this Department has made extensive studies and preliminary plans for numerous projects necessary for the development and growth of this City. Tunnels, traffic routes, reclamation and industrial districts, widening and extension of main arteries, etc., have occupied a large portion of the time of our office.

Progress on all sections of the Hetch Hetchy Water Supply System under way was very satisfactory and at the close of the fiscal year prospects were favorable for carrying on the work as previously outlined in a systematic and economical manner.

The only other engineering work which bears comparison in magnitude with the Hetch Hetchy Project is the Ashokan Water Supply System of the City of New York, on which over $186,000,000 has been spent to date. Bookkeeping records disclose the cost of engineering on the Ashokan Project has been over 10 per cent and the rights of way and legal charges have been 11½ per cent. In glaring contrast to

this our accounts up to date on the Hetch Hetchy Project show the engineering expense has been less than 5 per cent and the legal expense less than 5½ per cent, which practically makes those two items alone on our project less than one-half similar cost items by the City of New York. The same economic scale can be applied to other features of our work.

The three principal divisions of the project under way are now near completion. The Mountain Division, including the dams and aqueducts, and the Moccasin Power Plant and Transmission Line to Newark, will be completed and in operation in April, 1925. The Board of Supervisors is endeavoring to find ways and means of disposing of this enormous power crop, consisting of over 300,000,000 kilowatt hours of energy, for which, as per last year's annual report, the people have offers of over $2,000,000 annually.

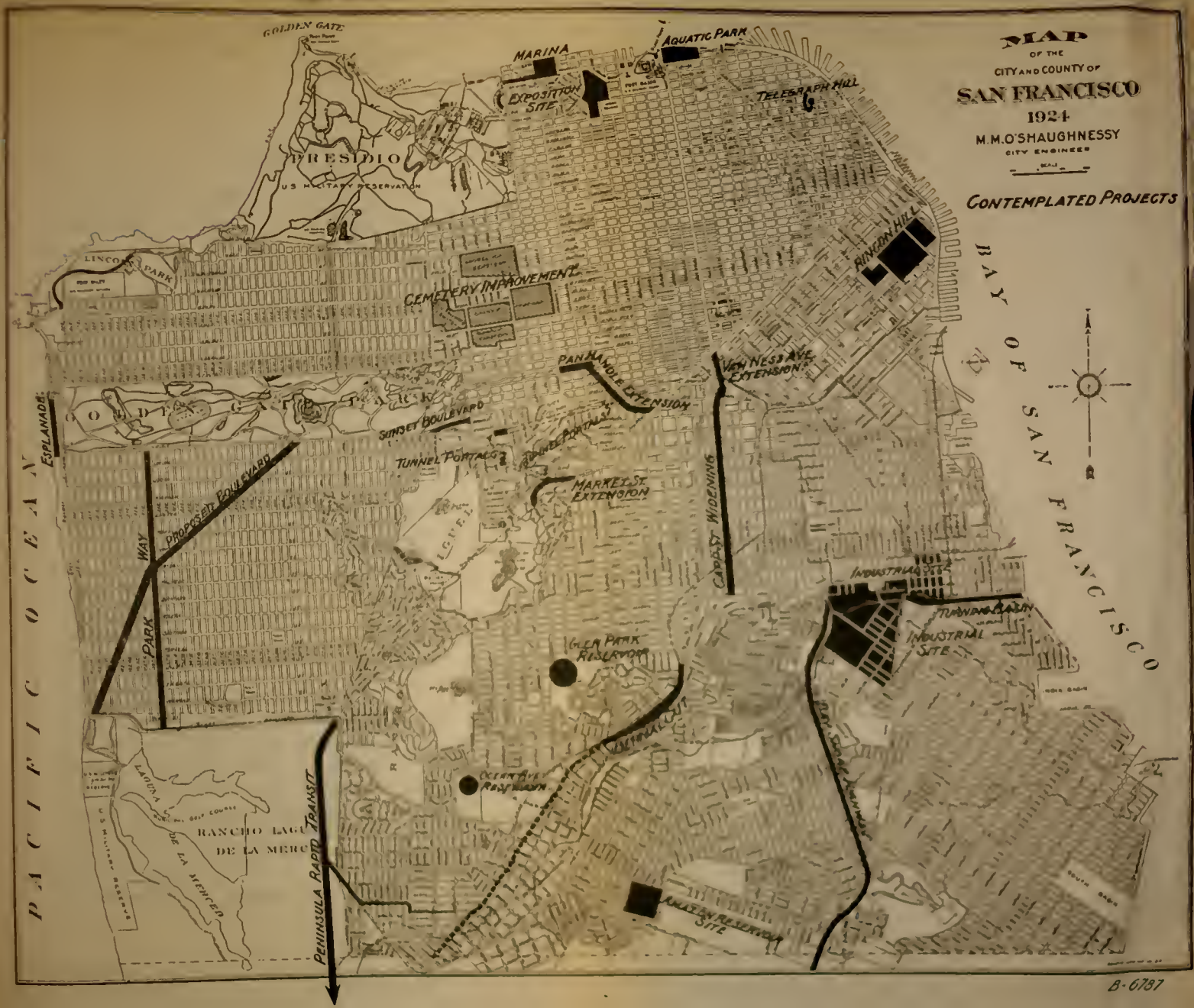
The Bay Crossing pipe line and connecting sections of aqueduct from Irvington to Crystal Springs Reservoir, the third principal division of work under way, will be completed during 1925. This will insure to the City sufficient additional water supply from Calaveras Reservoir of the Spring Valley Water Company to provide for the increasing needs of the City until completion of the remaining portions of the aqueduct across the San Joaquin Valley under an economic plan of construction.

Despite the disturbed conditions and unsettled policies, the loyalty of all the municipal employes in this Department, both office and field, has remained undisturbed, and all have worked to the best of their ability for the interests of the City and its citizens.

Respectfully,

M. M. O'SHAUGHNESSY,

City Engineer.


MAP
OF THE
CITY AND COUNTY OF
SAN FRANCISCO
1924
M.M.O'SHAUGHNESSY
CITY ENGINEER
CONTEMPLATED PROJECTS
GOLDEN GATE
MARINA
AQUATIC PARK
EXPOSITION SITE
TELEGRAPH HILL
PRESIDIO
U.S. MILITARY RESERVATION
LINCOLN PARK
RINCON HILL
CEMETERY IMPROVEMENT
GOLDEN GATE PARK
PAN HANDLE EXTENSION
VAN NESS AVE. EXTENSION
ESPLANADE
SUNSET BOULEVARD
TUNNEL PORTALS
TUNNEL PORTALS
MARKET ST. EXTENSION
PROPOSED BOULEVARD
WAY
PARK
CASTRO WIDENING
INDUSTRIAL SITE
INDUSTRIAL SITE
GLEN PARK RESERVOIR
INDUSTRIAL SITE
OCEAN AVE. RESERVOIR
LAGUNA
RANCHO LAGUNA DE LA MERCED
PENINSULA RAPID TRANSIT
AMAZON RESERVOIR SITE
PACIFIC OCEAN
BAY OF SAN FRANCISCO
B-6787

INTRODUCTION

To insure San Francisco provision for the future, and to keep abreast with the inevitable growth of this City, a construction program of great magnitude is required. Numerous projects for the development and extension of streets and transportation routes through San Francisco have been subjects of careful and extensive studies by this department during the past few years. Some of these projects are in the preliminary stages only, while others are well on towards accomplishment. Because of increasing property values and the impending construction of expensive buildings, immediate action towards procuring necessary lands should at once be taken on many of these improvements. Among the many works planned are:

Sunset Tunnel (Duboce Avenue Route);
Mission-Sunset Tunnel (Eureka Valley Route);
Municipal Railway Extension into the Ocean View District;
Van Ness Avenue Extension southerly;
Capp Street Widening;
Park Panhandle Extension;
Bernal Cut;
Rincon Hill Regrade;
Sunset Boulevard;
Sunset Diagonal Arteries;
Parkways in Richmond and Sunset Districts;
San Francisco Bay Shore Boulevard;
Market Street Extension Completion;
Telegraph Hill Boulevard Completion;
Golden Gate Heights Improvement;
Ingleside Heights Resubdivision;
Islais Creek Reclamation Project;
Roosevelt Way;
Southern Heights Avenue.

PROJECTS AND INVESTIGATIONS

Sunset Tunnel:

The **Sunset Tunnel (Duboce Avenue Route)** will relieve the surface transportation and reduce the time of travel between the Sunset District and downtown section. This project has been described in detail in previous reports. Although strongly recommended by this department for immediate construction, in preference to all other routes, no further progress has been made during the previous year, due to the consideration of the alternative Mission-Sunset Tunnel project by the Board of Supervisors. Pending definite disposition of this latter project, the hearings on the Duboce Avenue Route have been temporarily postponed.

In response to the request of the Board of Supervisors this office, on August 13, 1923, submitted a full detailed estimate and report on various tunnel schemes for connecting Eureka Valley and the Sunset District—known as the **Mission-Sunset Tunnel Project, (Eureka Valley Route).** The following copy of the letter of transmittal and table cover the various schemes considered:

August 13, 1923.

"To the Honorable Board of Supervisors,
San Francisco.

Gentlemen:

Pursuant to your request, made at your meeting of May 14th, 1923, I am transmitting herewith my report in the matter of the construction of a tunnel or tunnels from Eureka Valley to the Sunset District under the elevation in the City and County of San Francisco whereon is situated Olympus Monument.

In this matter of the construction of a dual tunnel from Eureka Valley to the Sunset District, four projects were considered;

Scheme I: A tunnel of 25 feet width for railway only, connecting under surface with Twin Peaks Tunnel at Ord Street, elevation 161 feet, and having a westerly portal elevation of 305 feet, near Cole Street and Alma Street. This tunnel would be 2660 feet long, would have a grade of 5.4 per cent, and would cost approximately $1,122,279.

Scheme III: A tunnel of 46 feet width, for combined vehicular and railway traffic, with an easterly portal elevation of 265 feet, near Merritt Street and Danvers Street, and a westerly portal elevation of 305 feet, near Cole Street and Alma Street. It would be 1634 feet long, having a grade of 2.45 per cent, and would cost approximately $1,368,107.

Scheme II: A tunnel of 35 feet width, for vehicular traffic only, with an easterly portal elevation of 265 feet, near Merritt Street and Danvers Street, and a westerly portal elevation of 305 feet, near Cole Street and Alma Street. It would be 1634 feet long, having a grade of 2.45 per cent, and would cost approximately $1,120,562.

Schemes I and II: Two separate tunnels, one 25-foot section, for railway traffic only, of length, grade and location of Scheme I, and one 35-foot section, for automobile traffic only, of 2.8 per cent grade, 1600 feet long, and of slightly different location from Scheme II. This scheme to cost approximately $2,133,304.

It is will be noted from accompanying table that transit time for railway traffic in the foregoing schemes is from three to five minutes longer than by the Duboce Avenue route. While the cost of either of the foregoing Schemes I, II or III is less than the tunnel on the proposed Duboce Avenue route, the use of either of those tunnels for rail transport would defeat rapid transit for the Sunset District, which is the present and urgent problem.

All schemes herein referred to will benefit the Eureka Valley District and the Mission District, but at the expense of the Sunset District. It would therefore seem equitable that the Eureka Valley and Mission Districts should be required to bear some of the cost of any tunnel located as set forth in the report.

I recommend the consideration of a vehicular tunnel of 35-foot section, similar to that of Scheme II, or a 46-foot

Sunset Tunnel—Eureka Valley Route

	Dia. of Tunnel Ft.	Cost of Track	Cost of Tunnel	Miles New Double Track	Distance Ferry to Ocean Miles	Running Time Mins.	Length of Tunnel	Tunnel Grade %	Heaviest Grade on Line %
Duboce Ave. Route	25	$567,000	$1,653,777	4.54	7.24	39	4232	3.00	7.00
Eureka Valley Route—									
Scheme I	25	$500,000	$1,122,279	4.14	7.61	42	2660	5.40	7.00
Scheme II	35	.....	$1,120,562	.....	.....	....	1634	2.45	.....
Sheme III	46	$563,000	$1,368,107	4.23	7.70	44	1634	2.45	8.00
Schemes I & II	25	$500,000	.....	4.14	7.61	42	2660	5.40	7.00
	35	.....	$2,133,340	.....	.....	....	1600	2.80	.....

Scheme I—A 25-foot railway section joining Twin Peaks Tunnel at approximately Ord Street, and having a westerly portal near Alma Street and Cole Street.

Sheme II—A 35-foot vehicular section, easterly portal located near Merritt Street and Danvers Street. Westerly portal located near Alma Street and Cole Street.

Scheme III—A 46-foot combination vehicular and railway section, same location as Scheme II.

Schemes I and II—A combination of the sections used in Scheme I and Scheme II, but with a slight change in position for Scheme II.

section, similar to that of Scheme III (but without provision for railway traffic), for future improvement. If a tunnel of either of these types is to be built and paid for by an assessment district, the Mission District and the Eureka Valley District should bear the major portion of the cost.

In view of the facts herein set forth I earnestly recommend the immediate construction of the tunnel on the Duboce Avenue route, and the future construction of a vehicular tunnel to connect Eureka Valley and the Mission with the Sunset.

Respectfully,

M. M. O'SHAUGHNESSY,

City Engineer."

Scheme III was favored by the Board of Supervisors and accordingly a resolution of intention, prepared by this office, was finally adopted on December 31, 1923. Thereupon this department prepared and submitted to the Board of Supervisors on May 31, 1924, a complete report (in 5 parts) covering as follows:

Part 1. Plans, profiles, cross-sections and general specifications.

Part 2. Estimates of cost of proposed tunnel including damages and incidental expenses.

Part 3. Maps of assessment district and lands to be benefited and assessed, also property to be acquired.

Part 5. Lists of properties affected and their respective amounts of assessments.

Parts 5. Description of parcels to be acquired or upon which easements are to be taken.

The statistical features of this report are embodied in the following table:

Mission-Sunset Tunnel

Length of tunnel—portal to portal		1,634 feet
" " " —over approaches		1,953 "
Height of tunnel		19 "
Width of tunnel		46 "
Width of roadway		40 "
Width of walk		6 "
Grade of tunnel and approaches		2.45%
Area Westerly District (approximate)	1,121 acres	
Area Easterly District "	434 acres	
Area Total District		1,555 acres
Number of parcels in Mission District	6364	
Number of parcels in Sunset District	9367	
Total number of parcels		15,731
Number of blocks		550
Cost		$1,572,654.41
City's Share		393,163.60
Balance to assess		1,179,490.81
Maximum rate per square foot (approximate)		.03¾
Minimum rate per square foot "		.00⅝
Maximum assessment 25x100 lot (approximate)		93.75
Minimum assessment 25x100 lot "		15.65
Time to complete		500 days

Consideration of the districts laid out and hearings of protests are being held by the Board of Supervisors.

Rincon Hill Regrade:

Rincon Hill Regrade project is rapidly approaching the actual construction stage. As described in the previous report, a syndicate has been suggested by the Chamber of Commerce to acquire the property and proceed with the regrading, and the following alternative propositions have been offered the owners of property in the Rincon Hill Regrade district:

A. To become shareholders in the syndicate, receiving an interest therein equivalent to their holdings.

B. Selling their holdings to the syndicate.

C. Taking down their own property independently, but in accord with the general project.

Options have been secured or agreement of owners to grade given on 60 per cent of the affected area.

Van Ness Avenue Extension:

The extension of Van Ness Avenue southerly from Market Street to 13th and Howard Streets is also well on the way to completion. A report was prepared and submitted to the Board of Supervisors who, on April 7, 1924, passed a resolution of intention to order the extension in accordance with this report. This report and the resolution of intention set out the boundaries of the district to be benefited and to be assessed for the costs of the extension.

Hearings on this scheme were set for various dates but no further action was taken, as the Board of Supervisors later agreed to the purchase, at this time, of property one block deep to Mission Street, paying for the same over a ten-year period and thus eliminating the assessment district. The costs of grading and paving will be borne by the properties fronting on the new street.

Islais Creek Reclamation District:

The reclamation of the lowlands in the Islais Creek drainage area for industrial sites has been under consideration by this office in conjunction with the San Francisco Chamber of Commerce. At this time the area being directly considered, approximately 277.5 acres, lies between San Bruno Avenue, Oakdale Avenue, Southern Pacific Trestle, Islais Creek, Third, Twenty-fifth, Iowa, and Army Streets. It is proposed to apply to the State Legislature for an enabling act authorizing the formation of a reclamation district to be assessed for the cost of this work.

The following are the main items involved in the construction:

Dredging Islais Creek Channel from the line of Selby Street to the outlet in San Francisco Bay, 200 feet in width, 37 feet below City datum.

A quay wall on the north bank of Islais Creek from Selby Street easterly, approximately 2000 feet in length.

A temporary wood box sewer along the existing channel, approximately 3400 feet in length.

Filling in and reclaiming 8,383,000 square feet, or 192.2 acres, of land.

Ingleside Heights:

The Ingleside Heights project is a similar one to the recently accomplished realignment of streets and resubdivision of Golden Gate Heights, but offers more difficulties in that some of the property affected is already improved. Although but slightly larger in area, the number of parcels involved is much greater.

	Golden Gate Heights	Ingleside Heights
Area	115 acres	122 acres
Parcels	194	1500
Owners	147	596

Tentative reassignments of lots are now being submitted to the property owners for approval. When 90 per cent of favorable requests are received, further action by this office will be taken.

Capp Street Widening:

Preliminary studies have been made for widening Capp Street from the proposed Van Ness Avenue Extension to Army Street as a connecting link to the Bernal Cut, thus affording a direct low grade thoroughfare through the center of the City from the bay shore on the north to the County line, and also relieving Mission and Valencia Streets from much of the heavy vehicular traffic. Capp Street, as proposed, would be widened to 305 feet, allowing for two 80-foot roadways with a maximum grade of 2½ per cent and with an elevated railway in the center. The length of this improvement is 8600 feet. The cost of the necessary lands is estimated at $6,000,000.

Bernal Cut:

The Bernal Cut Improvement has been before this department since before 1913 when, in granting a new franchise to the Southern Pacific Railway Company, it was stipulated that the City be granted a right of way through the existing Bernal railway cut. The necessary grading to accommodate a paved roadway was also made an obligation of the railroad company. The proposed plan provides a clear width of 117 feet 6 inches at the bottom of the cut, allowing for a 42-foot roadway, a double track street railway line, a double track interurban line of the Southern Pacific Company and an eight-foot sidewalk. The cost of this improvement is now estimated at $1,000,000, being $450,000 for property and $550,000 for the improvement, exclusive of the grading to be done by the railroad company. This estimate is almost double the original estimate due to the increased cost of labor and material. It is hoped that there will be no further delay in appropriating the funds for this work.

Park Panhandle Extension:

The extension of the Park Panhandle on a natural water grade from Baker Street easterly three blocks, thence southeasterly to Market Street at Dolores Street, will eliminate much of the cross traffic danger and many of the right angle turns on the present zig-zag route from the Mission into Golden Gate Park. In addition to its esthetic value as a parkway, its value as a fire barrier will be significant. The proposed extension will be 4600 feet in length with a maximum grade of four per cent. The 200 foot width planned will allow of a 46-foot boulevard, two 27-foot commercial roadways, 10-foot walks and 80 feet of park. The value of the necessary lands and buildings on the same is now approximately $3,000,000. Several large improvements are planned by property owners in the line of this extension, and therefore further delay in providing funds for the purchase of the property will greatly increase the cost of the project.

Sunset Boulevard:

Another roadway projected would run through Golden Gate Park from Stanyan and Waller Streets along the northerly side of the new stadium to Lincoln Way and 2nd Avenue, providing a cut-off to the Sunset District. This roadway would be 100 feet in width and approximately 2000 feet in length.

Diagonal Boulevard and Parkways in Sunset and Richmond Districts:

Studies have been made for a diagonal main artery through the Sunset District and for parkways through the Sunset and Richmond Districts. The diagonal road would start at 19th Avenue and Lincoln Way and run to Sloat Boulevard and Great Highway. The Richmond Parkway as proposed would be from Lincoln Park at 33d Avenue to Golden Gate Park near 31st Avenue; while the Sunset Parkway would extend from Golden Gate Park to Sloat Boulevard between 38th and 39th Avenues. These parkways, 240 feet in width, will serve, in addition to use as traffic routes, as fire barriers in case of conflagration.

Miscellaneous Activities:

The following are a few of the minor activities of this department during the past year:

Preparation of sketches to accompany application to the War Department for permit to construct a bridge over the Golden Gate, and showing routes, grades, profiles and connecting roadways.

Issued plans and supervised installation of improved weighing device at Municipal Asphalt Plant.

Investigated and reported to the Board of Public Works on the motorization of the Street Cleaning Department, including sweepers, bunkers, etc.

Drew up specifications for motor trucks to be purchased for use of Street Cleaning, Street Repair and Sewer Repair Departments.

WARREN HARDING MEMORIAL (Lincoln Park) BOULEVARD.
Scenic roadway through Municipal Golf Links on top of cliffs of the Golden Gate—recently graded and macadamized

MARINA BOULEVARD.
Boulevard along the shore of San Francisco Bay from Fort Mason to the Presidio on edge of residential tracts.

BOULEVARDS, STREETS AND HIGHWAYS

The cost of street improvements completed during the fiscal year under public, private and City pay contracts was approximately $1,458,600. The latter part of this fiscal year has seen the opening of many large residential tracts. These tracts are being improved as a whole and as a result a great amount of street work has been and is now being carried on under private contract permits from the Board of Public Works. Specifications, diagrams, lines and grades, inspection and final quantities are furnished by this department as in all street improvements.

Contracts were under way on the following boulevards:

Lincoln Park Boulevard—grading and macadamizing;

Telegraph Hill Boulevard—grading;

Sloat Boulevard and Great Highway Intersection —paving;

Great Highway opposite Fulton Street—paving;

Marina Boulevard—paving;

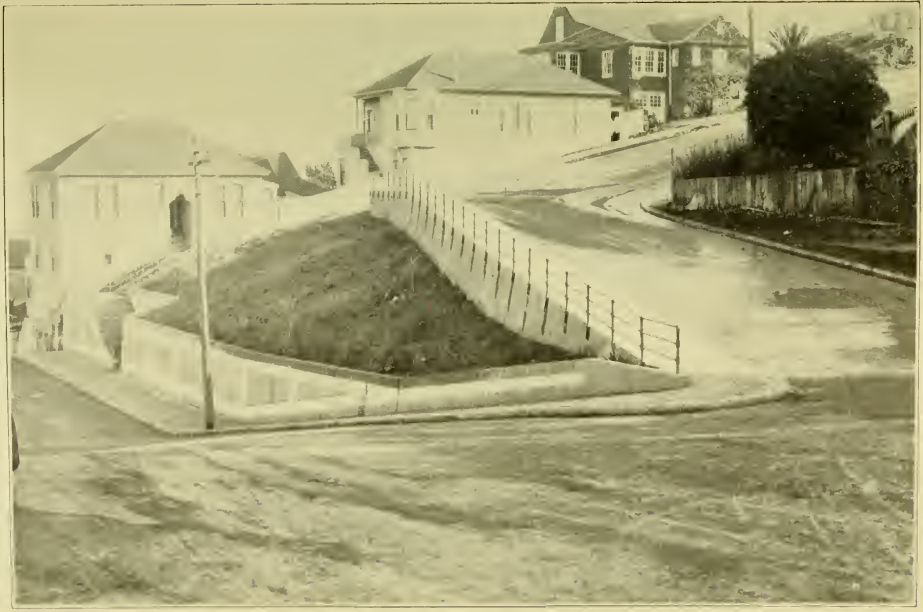
San Jose Avenue—widening and paving.

Paving was completed on Liberty and Sanchez Streets and is now being placed on Collingwood, Twenty-first and Twenty-second Streets; these being two of the special treatment improvements which were graded during the previous year. Other street improvements of importance completed were:

North Point Street, Columbus Avenue to Embarcadero—134,100 sq. ft. asphaltic concrete pavement;

Ulloa Street, Nineteenth Avenue to Twenty-seventh Avenue—125,800 sq. ft. asphaltic concrete pavement;

LIBERTY AND SANCHEZ STREETS—SPECIAL TREATMENT IMPROVEMENT.
Retaining walls, double roadways and stairways, used to make hillside property accessible.



LIBERTY AND SANCHEZ STREETS—SPECIAL TREATMENT IMPROVEMENT.
Re alignment of streets to reduce grades.

Twenty-seventh, Twenty-eighth, Twenty-ninth and Thirtieth Avenues, Ulloa Street to Vicente Street—10,000 sq. ft. concrete pavement, 86,000 sq. ft. asphaltic concrete pavement;

Napoleon Street, Jerrold Avenue to Evans Avenue—25,000 cu. yards. fill;

Stulsaft Tract—10,200 cu. yds. cut, 61,500 sq. ft. asphaltic concrete pavement, 2,200 ft. ironstone pipe sewers.

The improvement of Buchanan Street from Hermann Street to Duboce Avenue, involving 33,000 cubic yards of cut and 12,000 square feet of asphaltic concrete and brick pavement is near completion, as is also the laying of 93,000 square feet of concrete and asphaltic concrete pavement on Wilde Avenue from San Bruno Avenue to Delta Street. In addition thereto, large amounts of pavement are being laid in the Marina-Vanderbilt, Marina Gardens, Westwood Highlands, and Balboa Terrace Addition tracts. A contract has been let for grading the roadway and paving a 20-foot center strip on Silver Avenue from Merrill Street to Vienna Street, being a length of 4600 feet. Another permanent improvement under way, the paving of Forty-eighth Avenue from Lawton Street to Taraval Street, is over 5300 feet in length.

The reconstruction work of the Bureau of Street Repair, under a budget of $380,000, was done with the cooperation of this office in furnishing lines and grades and working diagrams. Profiles were furnished also for reconstruction work on the tracks of the Market Street Railways in various sections of the City.

Telegraph Hill Boulevard:

The grading of a boulevard, winding to the top of historic Telegraph Hill, has been completed. Beginning at Kearny and Lombard Streets, a 22-foot roadway with a maximum grade of 9 2/3 per cent has been cut in the hill for a length of 1450 feet to a parking circle at the peak of the hill. Over 19,000 cubic yards of rock were

COLLINGWOOD STREET—SPECIAL TREATMENT STREET IMPROVEMENT
Section of improvement, illustrating reduction of grade by double roadways and terraced walks

CAINE AVENUE, FROM LAKEVIEW AVENUE NORTHERLY.
SPECIAL TREATMENT STREET IMPROVEMENT.
Illustrating elimination of warp in street by double roadway and sloped parking.

removed and the necessary walls and drainage ditches, etc., constructed at a cost of $25,963.81 to the City.

Sloat Boulevard and Great Highway Intersection:

Over 70,000 square feet of pavement were constructed at the junction of Sloat Boulevard, Great Highway and Skyline Boulevard. An underground pedestrian passageway was constructed beneath the southerly paved strip of Sloat Boulevard, from a ramp at the terminus of the street railway line and leading to the new Municipal Playground and Swimming Pool.

Great Highway opposite Fulton Street:

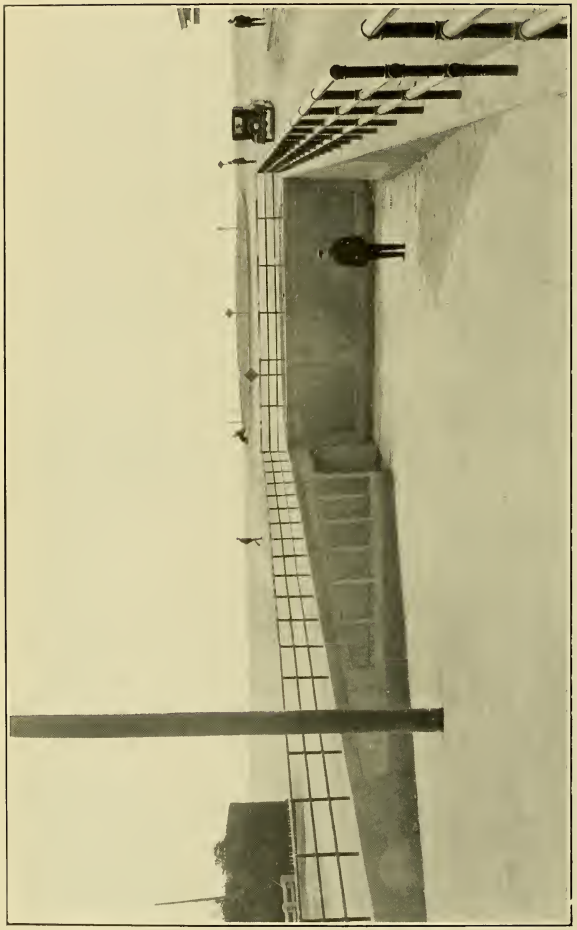
The paving of an area of 23,000 square feet on the westerly one-half of the Great Highway opposite Fulton Street, fronting on the recently constructed section of Esplanade, completes the improvement of this boulevard to the full 150-foot width from Point Lobos Avenue to the North Drive of Golden Gate Park. Further widening and improvement of the highway to the south is contingent on the removal of the Chalet and extension of the sea wall.

Lincoln Park Boulevard:

The construction of a road through Lincoln Park from the Legion of Honor Memorial to Forty-eighth Avenue and Point Lobos Avenue is progressing rapidly and this scenic drive around the cliffs of the Golden Gate will soon be opened to traffic. The present contract includes grading, drains, walls and macadamizing,—a more permanent type of pavement will be placed after the heavy fills have settled sufficiently.

Marina Boulevard:

The rock fill along Marina Boulevard fronting on the Yacht Harbor has been completed. Thirty-three thousand tons of massive rocks were dumped to form a sea wall behind which suitable material has been placed to carry the roadway. A contract has been recently awarded for the paving of the boulevard from Steiner Street to Lyon Street.



SLOAT BOULEVARD, GREAT HIGHWAY AND SKYLINE BOULEVARD INTERSECTION.
Traffic circle in intersection and ramp approach to underground pedestrian passageway under Sloat Boulevard.

San Jose Avenue:

San Jose Avenue from the County Line to Bernal Cut is the southerly link in the proposed cross town thoroughfare which will embrace Van Ness Avenue, Capp Street and Bernal Cut. Property has been acquired for widening the existing avenue to 80 feet, and a section of the road has been improved. A contract for moving and resetting curbs and catchbasins and for paving the additional strip from Havelock Street to Cotter Street has recently been let. A permit for the improvement, under a private contract, from Oneida Avenue to Geneva Avenue has been issued, the old roadway in this section having never been improved.

Plans have been prepared for a concrete viaduct to carry the roadway over the double tracks of the Southern Pacific Railway at Mount Vernon Avenue, to cost $150,000.

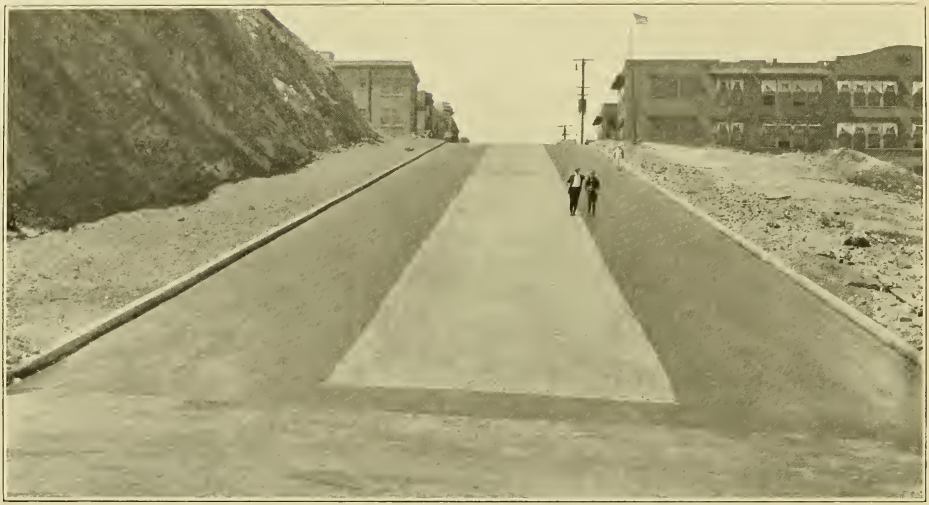
San Francisco Bay Shore Boulevard:

Surveys and general plans have been made on the section of the San Francisco Bay Shore Boulevard lying within the City limits. Further action on this section is contingent on appropriation of funds.

Construction of the 5-mile section between South San Francisco and Burlingame should be started shortly, as the State Highway Commission will receive bids on July 28, under revised plans and specifications; bids received recently under original plans having been rejected.

Market Street Extension:

The purchase of property needed for the remaining link of the extension of Market Street, being the section from Hattie Street to Mono Street in Eureka Valley, has been carried on. Upon the appropriation of additional fund, the remaining pieces of property will be secured. Construction should proceed shortly thereafter, so that this much needed improvement can be finished, and the West of Twin Peaks District be equipped with a first class driveway.



BUCHANAN STREET, DUBOCE AVENUE TO HERMANN STREET.
Recent improvement involving 33,000 yards of rock grading to remove portion of existing hill.

Roosevelt Way:

Nearly all of the properties along the projected line of Roosevelt Way, from 14th and Alpine Streets to 17th and Clayton Streets, have been purchased at a cost to the City of San Francisco of $121,000. Detailed plans will be issued and proceedings started for this improvement during the coming year.

Southern Heights Avenue:

Plans have been prepared and most of the rights of way secured for the low grade diagonal street in the Potrero Hill section connecting Rhode Island Street to Carolina Street between 20th and 22d Streets. A contract for the grading and construction of retaining walls on this new street will be let within a few months.

Golden Gate Heights:

Following the realignment of streets and the resubdivision of the Golden Gate Heights district by this department in conjunction with the various owners, the improvement of the streets is now being planned. Grade studies covering this district are being completed and plans for retaining walls, steps, drainage, etc., are under way. About five miles of thoroughfare are to be improved under this project at a cost of approximately $1,000,000.

Virginia Avenue Widening:

The widening and improvement of Virginia Avenue from Mission Street to Coleridge Street has been a problem before this department for many years. This street, which is the only easy gradient outlet to Mission Street from the immediate surrounding district, and also from Bernal Heights, has in this block a width of only 20 feet. After many hearings, protests, and delays, an assessment district was laid out and accepted, and the land has been bought for widening the street to 60 feet. A contract will be let for improving the street. The total cost of the land and improvement is estimated at $51,000, of which amount the City has contributed $30,000.

CORTLAND AVENUE FROM SAN BRUNO AVENUE WESTERLY.
Concrete pavement recently constructed.

STREET WORK PERFORMED UNDER CONTRACTS

July 1, 1923—June 30, 1924

	Quantity	Cost
Asphaltic Concrete Pavement, 6″ concrete base. Wearing surface 1½″, paint coat	189,527 sq. yds.	$ 515,239
Asphaltic Concrete Pavement, with vitrified brick strip, 6″ concrete base		
Wearing surface 1½″, paint coat	2,114 ″	5,511
Vertical fibre brick	1,129 ″	6,233
Asphaltic Concrete Pavement, with basalt block strip, 6″ concrete base		
Wearing surface 1½″, paint coat	78 ″	229
Basalt block, gravel filler	49 ″	230
Asphalt Pavement, with basalt block strip, 6″ concrete base		
Wearing surface 2″	34 ″	121
Basalt block, gravel filler	19 ″	143
Asphalt Surface	19 ″	17
Concrete Pavement, 6″	43,193 ″	116,515
Vitrified Brick Pavement, vertical fibre brick	222 ″	1,200
Broken Stone Pavement	200 cu. yds.	600
Gutter, concrete	567 sq. yds.	2,286
Curb		
Granite (new)	492 ft.	864
″ (reset)	540 ″	479
″ (redressed and reset)	88 ″	88
Concrete, armored	130,988 ″	115,153
Wheel Guard, concrete	1,338 ″	1,181
Coping		
Concrete	1,056 ″	2,525
″ armored 14″	948 ″	1,896
Headers, Redwood	1,079 ″	165
Sidewalks, Artificial Stone	18,043 sq. yds.	37,841
Grading		
Cut	139,035 cu. yds.	145,366
Fill	35,117 ″	18,083
Walls, Stairways, etc.		
Retaining Walls, Ramps, Tunnel, etc., concrete		54,978
Rubble Walls		365
Seawall, rock	32,170 tons	80,850
Stairways, concrete	5 flights	825
Entrances, concrete	2	415

	Quantity	Cost
Pipe Railings	860 ft.	3,010
Guard Fence	1,390 "	1,042
Sewers—Ironstone Pipe		
6" (side sewers)	3,843 ft.	6,081
8"	12,829 "	35,134
12"	6,960 "	20,874
15"	1,489 "	6,982
15" (in concrete)	440 "	2,970
18"	671	2,682
Sewers—Concrete		
2' x 3'—on piles	288 "	5,760
6' "	633 "	31,333
8' x 10'	405 "	19,242
8' x 10'—on piles	1,255 "	67,743
8' 6" x 10'	896 "	58,867
Taper Connections	4	2,340
Y's—on I. S. P. Sewer		
On 8" Sewer	741	1,444
" 12" "	272	669
" 15" "	77	147
" 18" "	41	82
Manholes		
On I. S. P. Sewers	103	13,161
On Concrete Sewers	13	1,722
Lampholes	7	315
Catchbasins		
New	154	19,956
Reset and Reconstructed	23	1,511
Stormwater Inlets	9	788
Culverts—10" I. S. P.	6,115 ft.	11,150
Underdrain—12" I. S. P.	633 "	950
Piles	44,907 "	26,258
Traps	2	6
Outlet Ditch, timbered	130 ft.	6,978
Total Costs		$1,458,595

Summary—Cost of Street Work

Work under public contracts	$ 485,830
" " private "	520,612
" " City pay "	452,153
Total	$1,458,595

SEWERS

Army Street Sewer Extension:

As the contract for the extension of the Army Street sewer was not completed at the time additional funds were made available, advantage was taken of the fair unit prices of the contract to include the construction of the outlet section. In all 2595 feet of reinforced concrete sewer,—some 8 feet 6 inches by 10 feet 6 inches basket-shaped, and some 8 feet by 10 feet flat top, partly on piles,—was constructed together with 130 feet of bulkhead ditch as the temporary outlet to the Channel. The extension of this sewer, which drains the lower Islais Creek district and carries also the storm flow of the upper section of the North Point main, has improved sanitary conditions so that the development of an industrial district along Islais Creek between San Bruno Avenue and the Southern Pacific Railway trestle is proceeding.

Sixth Street Sewer:

A reinforced concrete sewer, 6 feet in diameter, on piles, was constructed in Sixth Street from Brannan Street to Townsend Street. This replaced an old 3-foot by 5-foot brick sewer, constructed in early days, which was in bad shape due to heavy traffic over it and settlement of the street. The sewer in the adjacent blocks, from Townsend Street to the Channel, is also in poor condition and will be replaced when sufficient funds are allowed.

Berry Street Outlet Sewer:

The construction of the South Basin Terminal building by the State made necessary the realignment and extension of the outlet sewer in Berry Street from Second Street easterly. 460 feet of 15-inch ironstone pipe sewer, encased in concrete, was constructed.

Tonquin Street Sewer:

Previous to the placing of the rock fill sea wall at the Yacht Harbor and the improvement of that section

of the Marina Boulevard, the temporary wooden pipe sewer in the Marina Boulevard (Tonquin Street) between Broderick Street and Divisadero Street, was replaced by a 2-foot by 3-foot concrete sewer on piles.

Side Sewers:

2659 application for side sewer installations, with deposits totaling $199,831.80, were received during the past year, many of the application covering two or more side sewers. This is an increase of 579 in applications, and $45,814.35 in deposits over the previous fiscal year. The cost of installation has been greatly decreased in the past two years that this work has been supervised by this office, as evidenced by the larger rebates to property owners. The use of a mobile compressor unit and air driven chisel in cutting through pavements has further tended to lessen costs and time necessary to install the side sewers.

Deposits Received for Side Sewers

1923	No. of Applications	Amount
July	189	$13,948.75
August	223	16,563.45
September	187	14,337.55
October	225	17,249.15
November	229	15,152.00
December	198	15,293.90
1924		
January	251	20,783.05
February	205	16,089.10
March	239	17,793.45
April	235	17,408.00
May	226	16,785.55
June	252	18,427.85
	2659	$199,831.80

Proposed Sewers:

The sum of $125,000 for the extension of main sewers included in the budget appropriations for 1924-1925 will provide funds for the extension of the sewer in the Great Highway from Ortega Street southerly, for the construction of a section of the Sunset Central District sewer, and

of outlet sewers in the Marina District. The originally planned system requires 2 feet by 3 feet and 2 feet 6 inches by 3 feet 9 inches reinforced concrete sewers supported on piles, for outlet sections in the former Panama Pacific Exposition site, now known as the Marina District. Owing to lack of funds at this time, and urgent demand for the construction of these sewers, due to the rapid development of the district, this department re-designed the portion of the system in this district, so as to allow the construction of 24 inch ironstone pipe sewers as outlets. These sewers are to be encased in concrete for which the City will pay the cost, the balance of the cost to be assessed to the property owners.

MISCELLANEOUS CONSTRUCTION

Street Signs:

Five hundred and thirty-six street signs of the standard type on poles were erected under contract. These were placed in several neighborhood business districts and along several of the outlying main thoroughfares, such as San Bruno Avenue, Railroad Avenue (Third Street), Ocean Avenue, and Nineteenth Avenue. In addition, 78 wooden signs designating alleys were placed on buildings.

Another contract for furnishing and installing signs will be let soon, under which signs will be further extended in the apartment house and business districts, north of Market Street and east of Van Ness Avenue, to replace the signs on gas lamps, as the latter are now being removed. Also, signs which have been up two years or more will be repainted where necessary.

Bridge Cleaning and Painting, and Repairs:

The bridges over the Channel Waterway at Third Street, Fourth Street and Sixth Street, and the bridge over Islais Creek at Third Street, were thoroughly cleaned and painted. The cleaning, except in a few places, was done by the sand-blast method.

This department also, throughout the year, instigated and supervised minor repairs to the different bridges throughout the City.

High Pressure System Extensions:

The extension of the auxiliary water supply (high pressure) system for fire protection on Leavenworth Street from Bay Street north to The Embarcadero, with branch lines along Beach, Jones and Jefferson Streets, was completed. A manifold for fireboat connection was placed under this contract at Leavenworth Street and The Embarcadero. The pipe and valves installed were furnished

by the City, the cost of installation being borne by the Standard Oil Company and the Shell Oil Company, who have large oil stations in the vicinity.

Ten inch lines were installed in North Point Street between Van Ness Avenue and Larkin Street, and in Larkin Street between Bay Street and Beach Street under another contract.

The district protected by these new lines is being built up with factories, warehouses and gasoline storage plants and is adjacent to the waterfront.

Municipal Water Supply System Extension:

Previous to the paving of Wilde Avenue from San Bruno Avenue westerly, new mains of the Municipal Water Supply System were laid in Wilde Avenue from the reservoir at Oneota Street to San Bruno Avenue. The City furnished the pipe, valves, and necessary fittings, and bore the cost of construction, which was done under a contract. 2115 lineal feet of 8 inch and 1013 lineal feet of 6 inch cast iron bell and spigot type pipe was installed, together with six fire hydrants and valves.

This municipally owned water supply system serves a district in the southeasterly section of the City, the water being pumped from wells.

MUNICIPAL RAILWAY

Market Street Railway Purchase:

In the past year nothing of a constructive nature has been done toward the acquisition of the properties of the Market Street Railway. A valuation of this property was made by this office during the year 1921, and all legislation necessary to take over the entire property of the Company, including their lines in San Mateo County, was provided by a public election held in November, 1923. Negotiations between the City and Market Street Railway have been in the hands of a special committee, appointed by the Mayor, of Supervisors and other City officials.

The importance of reaching a definite settlement of this question has been pointed out in several previous instances. The dual ownership, with the pending acquisition of the private corporation, makes it difficult to properly expand the Municipal system. Franchise conditions, which have not been modified pending the outcome of the purchase, will not permit the private corporation to make extensions vitally necessary to the welfare of the citizens. Many requests for extensions into districts not now adequately provided with street railways are received by the City, and there seems to be no means of successfully solving the problems which these requests bring up.

At the present time there are no surplus funds, either from the sale of bonds or from earnings, nor does the present rate of fare show a possibility of surplus funds in the immediate future. Under these circumstances, the only way to secure Municipal Railway extensions is through the issuance of bonds. This matter has been frequently discussed, but action has been deferred by the Board of Supervisors on the grounds of waiting for the outcome of the negotiations for the purchase of the Market Street System.

Extensions:

The status of the major extensions proposed recently is more fully described as follows:

Ocean View Line: During the past winter and spring, construction work on this line from the junction of Sloat and Junipero Serra Boulevards, through the Spring Valley property, along Worcester, Randolph, Orizaba and Broad Streets into the Ocean View District has been prosecuted. The right of way has been graded and the trolley poles set, but, on account of the extreme dryness of the season, the very deep fills necessary to cross the ravines in the Spring Valley property have not settled sufficiently to allow operation of heavy cars over them. The work will be carried on so as to have cars running as soon as these fills and the paving of streets in the Ocean View District will permit.

Sunset District Line: The Sunset District, an important and growing section of the City, has been waiting for a definite solution of the tunnel problem on which street railway transportation into the district depends, and which has been described in a previous section of this report. All of the Market Street Railway lines running into this district are badly overcrowded during the rush hours, with no hope for relief as the Company is already operating all the cars possible over the steep Haight Street grade leading to the district.

During the past year, the route of the Municipal Railway bus operating from 10th Avenue and Fulton Street in the Richmond District to 25th Avenue and Irving Street in the Sunset District has been extended to 35th Avenue and Irving Street.

Balboa Street Line: Last year, in a report on railway extensions, attention was called to the fact that the Richmond District had grown to such an extent as to warrant the construction of an additional line on Balboa

Street. As with other pending extensions, failure to determine what is to be done with the Market Street Railway purchase prevents the solution of this particular problem of providing the necessary transportation along this street.

Embarcadero Bus Line: The establishment of a transportation route along the water front has not as yet been accomplished. This has been under discussion since 1917 when a report was first made to the Board of Supervisors by the City Engineer. During the past year, this Board has had under consideration the proposal of a private firm of being granted an exclusive permit and subsidy for the operation of automobile buses along the water front. Some doubt exists as to the legality of giving a subsidy to a private firm for such purpose. The State Board of Harbor Commissioners has verbally agreed to give the City a subsidy of $18,000 a year for three years if the City operates the automobile buses, or will be agreeable to giving one-half of this sum provided the City gives an equal amount and a permit to operate buses to a private individual or firm. The City Attorney has drawn up on ordinanc covering the granting of such an exclusive permit, but this ordinance is still before the Public Utilities Committee of the Board of Supervisors. The Mayor has made several requests on the Board of Supervisors to take definite action, but at this time the water front problem is as far from solution as it was in 1917. Any system of transportation along the water front may, from the City's standpoint, be expected to prove a failure financially.

Equipment:

The twenty standard cars built by the Bethlehem Shipbuilding Corporation under contract were all delivered by October, 1923, and placed in service with very satisfactory operating results.

Carbarns and Shops:

Plans and specifications for the addition of a second story to the Seventeenth Street Carbarn are complete.

Four additional tracks for the storage of street cars are provided in the plans, together with a considerable amount of office space on the Seventeenth Street side of the Barn. They also will furnish commodious waiting and recreation rooms for the employees, together with considerable storage and locker space.

The City Attorney's office has been engaged for over a year in trying to secure the block of land immediately west of the present Seventeenth Street Carbarn. Possession of this land would make possible the erection of a modern and efficient car repair shop and provide a yard for storage of maintenance of way materials, tools and equipment. This particular location is mose desirable as it has direct connection with the Municipal Railway lines and also can receive direct switching service from the Southern Pacific Railway.

Power Rates and Facilities:

Effective February 20, 1923, the State Railroad Commission fixed the rates to be charged for electric power used in the operation of street railways as follows:

1.15 cents per kilowatt hour for the first 300 kilowatt hours per month for each kilowatt of maximum demand.

1 cent per kilowatt hour for all power over 300 kilowatt hours per month per kilowatt of demand.

Minimum charge $2.50 per month per kilowatt of maximum demand.

These prices apply to direct current such as has always been purchased from the Pacific Gas and Electric Company. The price on the original contract with this company has been one cent per kilowatt hour for all power consumed, with no minimum charge. Under the contract rate, very heavy penalties were exacted from the Company in case of the interruption of service, whereas the Railroad Com-

mission provides for a very moderate penalty for the interruption of service. The power consumption by the Municipal Railway during the past year under the new rates has been such that the charges always exceeded the minimum and a fairly large portion of the power was purchased at the one cent rate.

The continued increase in the number of cars operating has resulted in fully loading the underground feeder cables supplying a number of lines, so that steps will shortly have to be taken to reinforce these cables with new conductors. Some of the system now in use on Geary Street was originally laid out for use with the 43 cars which were purchased out of the first bond issue for Municipal Railways of 1910.

CURRENT CONTRACT DATA, 1923 - 24

LOCATION	CONTRACTOR	Date of Award	Date Completed	Per cent Completed	Amount of Completed Contract	Amount Expended to June 30,1924	FUNDS
BOULEVARDS, PAVING AND GRADING							
Ballingwood, 21st and 22d Streets (Grading and walls)	C. B. Eaton	9/18/22	12/12/23	100	$ 79,157.32	$ 34,201.16+	Public Assessment and General Fund
Sloat Boulevard (northerly 1/2) 19th Avenue to 35th Avenue	Eaton & Smith	12/ 8/22	6/ 6/23	100	45,594.17	45,594.17	County Roads
Warren Harding (Lincoln Park) Boulevard	Jas. R. McElroy	2/ 8/23		90	109,612.57	66,000.00	County Roads
Telegraph Hill Boulevard	Louis J. Cohn	4/23/23	11/21/23	100	25,963.81	25,963.81	County Roads
Great Highway and Sloat Blvd. Intersection	Louis J. Cohn	6/ 1/23	1/30/24	100	42,655.97	40,082.18a	County Roads and Special Fund
Great Highway (Westerly 1/2) opposite Fulton Street	Louis J. Cohn	7/16/23	11/21/23	100	7,643.60	7,643.60	County Roads
Liberty and Sanchez Streets (Paving)	Municipal Constr. Co.	8/20/23	1/21/24	100	24,377.13	24,377.13	General Fund
Ballingwood, 21st and 22d Streets (Paving)	Municipal Constr. Co.	10/19/23		90	30,827.03	17,000.00	General Fund
Buchanan Street Hermann St. to Duboce Avenue	Jas. R. McElroy	10/24/23		65	39,955.75	9,825.00	Public Assessment and County Roads
Avalon Avenue, London and Paris Sts (Grading & Sewers)	Municipal Constr. Co.	11/21/23	1/23/24	100	4,748.35	4,748.35	County Roads
Silver Avenue Merrill St to Vienna St.	Municipal Constr. Co.	2/29/24		50	32,671.85		Public Assessment and County Roads
Marina Boulevard (Tonquin St.) Lyon St to Steiner St.	Municipal Constr. Co.	4/21/24			56,488.70		County Roads
San Jose Avenue Havelock St to Cotter St.	Municipal Constr. Co.	5/19/24			12,892.43		County Roads
SEWERS							
Army St. Sewer Extension	Clinton Constr. Co.	1/29/23	1/30/24	100	171,100.55	171,100.55	General Fund
Bay View District Septic Tank	J. D. O'Hara	1/ 3/23		90	499.00		General Fund
6th St Sewer, Brannan to Townsend	Healy-Tibbits Constr.Co.	9/21/23	3/25/24	100	45,394.78	45,394.78	General Fund
Berry St Outlet Sewer Second Street southerly	Louis J. Cohn	2/25/24	5/ 5/24	100	3,195.00	1,597.50b	General Fund and State Harbor Commission
Marina Blvd (Tonquin St.) Sewer Broderick St. to Divisadero St.	Louis J. Cohn	8/20/23	12/ 5/23	100	8,792.00	8,792.00	County Roads

12n				
13n				
13n				
13				
13n				
13n				
13n				
14n				

+ E

a E

b E

c A

CURRENT CONTRACT DATA 1923 - 24

YC	LOCATION	CONTRACTOR	Date of Award	Date Completed	Per cent Completed	Amount of Completed Contract	Amount Expended to June 30,1924	FUNDS
			MUNICIPAL RAILWAYS					
132A	Street Car Bodies	Bethlehem Shipbuilding Corp.	9/ 8/22	9/27/23	100	$152,195.00	$152,195.00	Mun. Ry. Depreciatio
132C	Street Car Motor Equipment	Westinghouse Elec. & Mfg.Co.	9/ 8/22	2/20/23	100	124,396.79	124,396.79	Mun. Ry. Depreciatio
132D	Street Car Air Brake Equipment	Westinghouse Traction Brake Co	9/ 8/22	2/ 8/23	100	11,300.25	11,300.25	Mun. Ry. Depreciatio
135	Stockton St. Tunnel-Painting	I. R. Kissel	12/21/23	1/28/24	100	1,300.00	1,300.00	Municipal Railway
136	Track Materials	U. S. Steel Products Co.	10/17/23	4/16/24	100	43,681.04	43,681.04	Mun. Ry. Depreciatio
137	Ocean View Line-Grading & Culverts	James M. Smith	12/21/23	4/ 4/24	100	39,620.97	39,620.97	Mun Ry. Depreciatio
139	Copper Trolley Wire	Standard Underground Cable Co	2/ 8/24	4/15/24	100	3 272.82	3,272.82	Mun. Ry. Depreciatio
140	Concrete Trolley Poles	James M. Smith	5/ 2/24		50	16,219.34	6,705.00	Mun Ry. Depreciatio
			MISCELLANEOUS					
	Esplanade, Section "D"	Healy-Tibbitts Constr.Co.	8/23/22	5/10/23	100	58,248.13	58,248.13	General Fund
	Rock Fill along Marina Blvd.	Healy-Tibbitts Constr.Co.	10/13/22	3/ 4/24	100	80,850.48	80,850.48	County Roads
	High Pressure Mains on Leavenworth, Beach, Jones & Jefferson Sts.	Hugh McGill	3/26/23	10/31/23	100	17,133.55	17,133.55c	Special Fund
	Street Signs (Contract No. 3)	Louis J. Cohn	8/20/23	1/ 2/24	100	8,910.30	8,910.30	General Fund
	High Pressure Mains on North Point and Larkin Streets	Hugh McGill	9/ 7/23	5/ 7/24	100	7,300.00	7,300.00	General Fund
	Bridge Cleaning & Painting, 3d,4th, & 6th Sts. over Channel and 3d St over Islais Creek	Conrad B. Sovig	10/22/23	5/ 2/24	100	19,057.95	19,057.95	General Fund
	Water Mains on Wilde Ave. -San Bruno Ave. to Oneota St.Reservoir	Eaton and Smith	2/23/24	4/ 9/24	100	2,972.96	2,972.96	General Fund

- Balance paid by public assessment on property owners.

a Balance paid by funds from Market Street Railway Company.

b Balance paid by State Harbor Commission.

c All paid by funds from Standard Oil and Shell Oil Companies.

SURVEYS

Surveys Performed

Made for	Number	
Public Contracts	111	
Private Contracts	247	
Resurveys for Contracts (lost points)	49	
Municipal Departments	368	
Total for Public Improvements, etc.		775
Lot Surveys—Private Owners	45	
Municipal Departments	12	
Total Lot Surveys		57
Total Surveys		832

Surveys include approximately 1721 blocks and crossings, a total length of 488,000 feet or 92 miles, in addition to 38 miles of monument line and highway work and the replacing and covering of 60 survey monuments.

Precise Levels and Bench Marks

District	No. of Bench Marks
50 Vara	651
100 Vara	375
Mission	428
Sunset	411
Potrero and South San Francisco	604
Western Addition	35
Richmond	53
Other Districts	364
Total Bench Marks	2,921
Precise Levels—Total Miles	115

Maps Approved and Filed With Recorder

Rotteck Street northerly from Springdale—Widening.

Landers Street—Widening and Extension.

Golden Gate Heights—a resubdivision of a portion of the Sunset District.

Rolph Street Extension.

Hawes Street Widening.

Block 26, West End Map No. 1—Resubdivision.

Humboldt Street Opening; widening of Twenty-fourth Street, and the closing of portions of Michigan, Georgia, Louisiana, Maryland, Delaware, Humboldt, and Twenty-third Streets.

Mission Street between Twenty-sixth and Army Streets—Widening.

Avalon Avenue Extension.

Howard Street Extension.

Laguna Honda Park.

St. Mary's Park.

Stulsaft Subdivision of Blocks 2 and 3 of West End No. 1.

Avila Street Extension.

Block 27, Ingleside Terraces.

Fees Received for Surveys and Inspection

	Surveys	Inspection
1923—		
July	$471.00	$691.50
August	894.00	851.00
September	260.25	1,097.25
October	1,349.25	1,316.25
November	390.95	384.75
December	1,139.00	4,933.75
1924—		
January	314.00	2,148.75
February	1,071.25	1,152.00
March	775.00	1,410.75
April	1,673.90	1,021.50
May	1,609.75	2,081.25
June	1,211.95	708.75
Total	$11,160.30	$17,797.50

STREET IMPROVEMENT ASSESSMENTS, ETC.

Assessments and Bonds for Street Work

Assessments issued for cost of street work performed	67
Cost of street improvements covered by assessments	$522,455.42
Bonds prepared (in triplicate)	234
Amount of assessments guaranteed by bonds	$ 91,846.00
Average amount guaranteed by each bond	$ 392.50

Street Work Proceedings

Resolutions of Intention passed	52
Street improvements recommended under Resolutions of Intention	92
Notices of street improvement posted	1,853
Notices of Resolutions of Intention mailed	3,140
Ordinances ordering performance of street improvements passed	85
Proposals of street improvements published	93
Public contracts for street improvements awarded	81
Private contracts filed	169

Notices, Permits and Investigations:

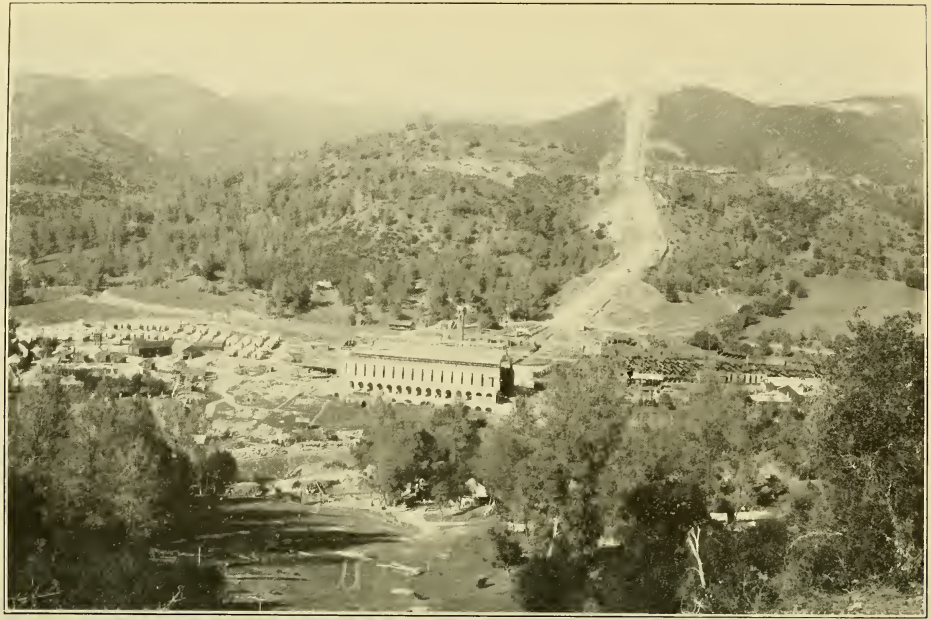
Notice to construct and repair sidewalks	1,836
Notice to construct bulkheads	639
Notice to remove obstructions	509
Notice to construct guard rails	19
Notice to reconstruct side sewers	310
Street space permits reported on	4,176
House moving permits reported on	73
Miscellaneous calls and investigations	2,611

Permits and Fees for Corporation Trenches, etc.

(In conformity with Ordinance 2201)

	Service connections and repairs	Mains installed lineal feet	Fees charged
Pacific Gas and Electric Co.	5,224	69,462	$8,398.50
Spring Valley Water Co.	5,774	28,025	8,883.00
Great Western Power Co.	113	5,850	217.50
Pacific Telephone and Telegraph Co.	237	20,609	523.50
Western Union Telegraph Co.	23	7,739	94.50
*Miscellaneous under Special Deposits	.....	.....	6,227.00
Total	11,371	131,685	$24,344.00

*Permits granted for which special deposits were made to move steam shovels and tractors, to repair or install oil tanks, service pipes, fire alarm wires, cables and conduits, to lower curbs, etc.



MOCCASIN POWER PLANT—HETCH HETCHY WATER SUPPLY PROJECT.
Showing power plant, penstock piers and construction camp.

HETCH HETCHY WATER SUPPLY

Progress and Developments

The Hetch Hetchy Water Supply during the fiscal year 1923-1924 has made rapid progress. Work on the Mountain Division is nearly completed and construction on the Bay Crossing Division in San Mateo County is well advanced.

The work of the year has been directed toward the completion of three of the principal divisions of the project: first, the aqueduct between Early Intake and Moccasin Creek, which will convey water to the power plant; second, the Moccasin Power Plant and transmission line which, taken together, form the initial large unit of power development; third, the section of the Hetch Hetchy Aqueduct extending from Irvington to Crystal Springs Reservoir which, in conjunction with certain work to be performed by the Spring Valley Company, will make available for immediate use on the Peninsula an additional daily flow of 24 million gallons of water from the Company's Alameda and Calaveras sources. Under this program, early in 1925, the City will be in position, should the Board of Supervisors so determine, to realize a large income from the sale of electric power, and will have sufficient water supply available to provide for the increasing needs until the aqueduct from Moccasin Creek to Irvington can be constructed at an economical rate of progress.

The diversion dam at Early Intake is under construction. The tunnels between Early Intake and Moccasin Power Plant have been excavated, and the tunnel lining is about 65% finished. Priest Dam has been completed. The penstocks for the 80,000 kv-a power plant are being installed, and the power house is ready for the installation of machinery. Transmission line right of way has been purchased, and foundations for towers are being constructed.

Pulgas Tunnel, at the westerly end of the aqueduct from Irvington to Crystal Springs Reservoir, is completed and more than half the pipe line from Irvington to the tunnel is laid. The trestles and bridge to support the pipe line across the marshes and Bay are under construction and cast iron pipe for the submarine siphons at Dumbarton Strait and Newark Slough is being manufactured.

To finance the completion of the aqueduct between Moccasin Creek and Irvington it will be necessary to issue additional bonds totaling $33,000,000. In order to preserve the City's water rights on the Tuolumne and to provide adequate water supply to keep pace with the rapidly growing demand, funds must be provided to permit the water construction work to be prosecuted continuously and diligently so that water from Hetch Hetchy may be delivered in San Francisco not later than 1930.

Organization and Headquarters Work

The work is under the general direction of M. M. O'Shaughnessy, City Engineer. Nelson A. Eckart, Chief Assistant Engineer, has direct supervision over all work on the Hetch Hetchy Water Supply.

City Headquarters Office:

The City Office staff designs and prepares plans and specifications for new work to be undertaken, prepares detail plans for work already in progress in the field, selects and purchases equipment and supplies for work being done by day labor or under "cost-plus-fee" contracts, and handles all bills and payrolls. Important items of work carried out in the City Office during the past year are: Design of Early Intake diversion works, design of Moccasin power plant and penstocks, design of Bay Pulgas pumping plant, trestles and other details of the Bay Crossing pipe line, and design of the Dumbarton Strait submarine siphon.

The headquarters staff includes: R. P. McIntosh, L. W. Stoeker and R. J. Wood, Civil Engineers; P. J. Ost, Elec-

trical Engineer; E. P. Jones, Mechanical Engineer; H. W. Kephart, Purchasing Agent; and a staff of assistant engineers, draftsmen and other employees.

A table of the important features of all the Hetch Hetchy Water Supply contracts prepared during the past year appears in the appendix to this report. This list is continuous with sheets printed in the reports for the two previous fiscal years.

Field Headquarters:

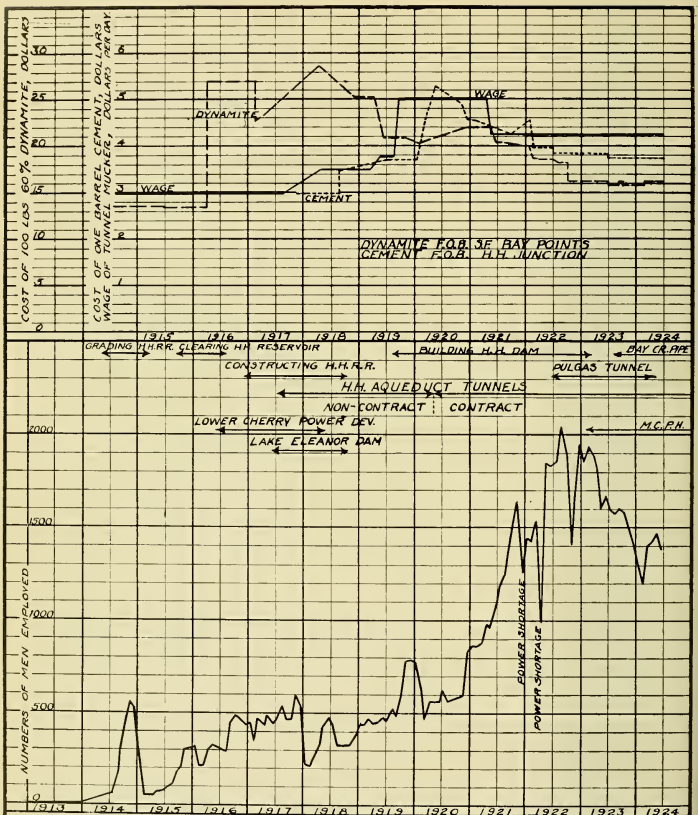
On the work in the Sierra Nevada, the two-division organization instituted in February, 1921, has been discontinued on account of the completion of O'Shaughnessy Dam which was the principal item of work under the upper division. Headquarters for all work east of the San Joaquin Valley and also for all work on the power transmission line are at Groveland in charge of L. T. McAfee, Construction Engineer. Field headquarters for the Bay Development, which includes the Bay Crossing and Peninsular Divisions of the Aqueduct, are at Palo Alto where C. R. Rankin, Construction Engineer, is in charge.

Employees in the Field:

The number of employees in the field varied form about 1200 to 1600, the average number being about 1450. The number and distribution on a typical day in June, 1924, were as follows:

Mountain Division tunnels	325
Moccasin penstocks	140
Moccasin power house	171
Railroad	91
Bay Crossing pipe line	75
Dumbarton Strait Bridge	93
Transmission line	225
General and Miscellaneous	265
Total	1378

These figures include both direct employees of the City and employees of contractors but do not include employees in the San Francisco office.



HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

UPPER: GRAPHIC RECORDS OF COSTS OF LABOR AND MATERIALS
LOWER: GRAPHIC RECORD OF NUMBER OF MEN EMPLOYED

NOTE: EMPLOYEES IN THE SAN FRANCISCO OFFICES ARE NOT INCLUDED IN THE COUNT

DEPARTMENT OF PUBLIC WORKS. APPROVED ..... CITY ENGINEER

BY H. O. S. . . TRACED H.O.S.. . CHECKED . . . . . .

SCALE . . . . . DATE JUNE 30, 1924.

A 165

Groveland Headquarters:

Practically no changes were made in the personnel of the Groveland headquarters staff during the fiscal year, the men released from work completed being required in connection with new work. No changes were made in the housing facilities.

Hospital: The City continued to maintain at Groveland a fully equipped hospital with a capacity of seventy-five patients. A physician and three trained nurses constitute the staff. Cases treated at the hospital during the past fiscal year were as follows:

Non-hospital cases		891
Hospital cases:		
City's direct employees	281	
Construction Co. of North America—(Tunnel Contract)	147	
Outside pay patients	192	
Total hospital cases		620
Total cases treated		1511
Capital operations		179
Average time in hospital for hospital cases		13.9 days

Groveland Water Supply: Water supply for the City's headquarters, shops and other requirements at Groveland is still obtained from the flow of water encountered in the mountain aqueduct tunnel through the Second Garrote Shaft. When the tunnel was holed through to Priest, necessity no longer existed for pumping the water from the tunnel and it now discharges freely from the Priest Portal except such as is required for the City's water supply. This water is pumped directly from the tunnel level to the City's water supply tanks above Groveland in one lift of approximately 800 feet by means of a 5½″x 8″ Gould pump with capacity of 120 gallons per minute, recently installed at the bottom of the shaft.

Due to lining operations, the water carries considerable sediment which is removed by filteration, two 6 x 10 Type

H horizontal pressure filterers, furnished and installed by the California Filter Company, taking care of this feature. In addition to filteration the water is given chlorine treatment.

Hetch Hetchy Railroad

The Hetch Hetchy Railroad is still operated as a common carrier, transporting freight, passengers and United States mail. Owing to an abnormally light winter, maintenance and operating expenses for the winter and early spring were unusually low and the road was in excellent condition in the spring of 1924. Additional yard tracks have been laid at the Moccasin power plant to handle material; otherwise no new construction has been undertaken. No changes have been made in rolling stock.

Freight Traffic:

With the completion of the O'Shaughnessy dam at the east terminus of the railroad the volume of freight business and average length of haul has been greatly reduced. During February and March, 1924, heavy shipments of penstock pipe for the Moccasin power plant were received. Although the railroad organization has been somewhat disrupted by slack business during the winter this sudden increase in tonnage was handled satisfactorily and with reasonable dispatch. All freight trains have been run as extras and every effort has been made to fit the service to the requirements, keeping expenses as low as possible.

Passenger Traffic:

Except for the summer excursion business, passenger traffic has decreased to a point where it can be handled by motor buses.

Daily through service between Hetch Hetchy Junction and points east of Groveland has been discontinued but daily service between Groveland and the Junction and between Groveland and points east has been maintained.

Special through service between Hetch Hetchy Junction and the Oakland Recreation camp on the Middle Fork of the Tuolumne was maintained on Saturdays only during the season through which the camp was operated.

The one day trip from Yosemite to Hetch Hetchy and return operated during the summer by the Yosemite Transportation System shows increasing popularity and a steam train has been provided to transport the passengers between Mather and Hetch Hetchy.

Week-End Excursions: During the last two summer seasons, in order that citizens of San Francisco might acquire first-hand information on the project, weekly excursions were conducted from San Francisco over the construction activities in the mountains. Organized parties of from 40 to 100 persons leaving the Ferry Building Friday nights via Southern Pacific or Santa Fe Railway, arrived at Hetch Hetchy Junction early Saturday morning. Leaving the Pullman sleepers at the Junction, they were taken on an excursion train over the City's railroad, spending Saturday and Sunday viewing the work at the various camps. Meals were served at the City's boarding houses. The trips includes half a day each at O'Shaughnessy Dam and at Early Intake and shorter stops at Mather, South Fork, Big Creek, Groveland, Priest Dam, Moccasin power plant and Red Mountain Bar. Upon returning to Hetch Hetchy Junction on Sunday evening, the parties boarded the Pullman cars and arrived in San Francisco on Monday morning at 8:00 o'clock. The fare of approximately $30.00 for the round trip represented the actual cost of handling the excursions.

The thousands of persons who made these trips were unanimous in their praise of the construction and expressed amazement at the magnitude of the work, which was far beyond their expectations. Many enthusiastic comments were made about the beautiful scenery seen from the City's

railroad, which probably surpasses the view from any other railroad in the country.

The week-end tours were made by a number of civic and fraternal organizations including the San Francisco Chamber of Commerce (three trips), Commonwealth Club (two trips), Down Town Association, Lafayette Club, Civic League of Improvement Clubs, Real Estate Board, Laundry Owners' Association, Contractor's Association, Rotary Club, American Institute of Electrical Engineers and others. The tours were under the guidance of Assistant Engineer L. B. Cheminant.

United States Mail:

Mail service has been maintained as in previous years, except that during the winter months, mail for Mather was delivered twice a week only.

O'Shaughnessy Dam

The O'Shaughnessy Dam completed in April, 1923, is described in considerable detail in previous annual reports. The only new construction this year at Damsite has been a concrete house, 16 feet x 28 feet, for storage batteries, pumps, etc. This is located on the top of the dam at the south abutment. Back of the building the accumulators used in connection with the hydraulic operation of the gate valves have been set up.

Dedication of O'Shaughnessy Dam:

On July 7, 1923, O'Shaughnessy Dam was formally dedicated by Mayor James Rolph, Jr., and a group of distinguished citizens gathered at the dam. Several hundred people were present at the dedication. A special train was run from San Francisco to accommodate those who went up from the City for the occasion and many persons came from the region in which the water supply development work is being prosecuted and from Yosemite Valley. Rep-

resentatives of the Modesto and Turlock Irrigation Districts were also present.

The program of dedication commenced with the official turning over of the completed dam to the City and County of San Francisco by W. H. Wattis, President of the Utah Construction Company, and acceptance in the name of the City and County by Timothy A. Reardon, President of the Board of Public Works. Mayor Rolph, following his introduction by Supervisor J. Emmet Hayden, Chairman of the day, delivered an address expressive of the significance of the occasion. Senator James D. Phelan, under whose administration as Mayor of San Francisco, the Tuolumne River was selected as the source of the greater San Francisco water supply, was the next speaker; in his talk he told of struggles which ensued during twelve years of effort to secure the rights which San Francisco now enjoys in the Yosemite National Park and other Government lands. After introducing to the audience the engineers on design and construction, the City Engineer then spoke describing the general policy of the Hetch Hetchy development and explaining the reasons for the various features of the construction work and for the adoption of the particular construction program that has been since followed. The ceremonies were closed with the singing of "The Star Spangled Banner" by the entire assemblage.

Lake Eleanor

During the flood season in the spring of 1924, a small crew was maintained at Lake Eleanor to float out logs remaining from the reservoir clearing work of previous years. The logs were floated to the log chute of the dam and carried out by the overflowing water.

Mather Sawmill

The sawmill at Mather was operated until late in 1923 but was not again placed in operation in 1924. A caretaker is maintained at the mill to attend to shipments of lumber

from stock on hand and to look after the mill and other City property in the vicinity.

During the fiscal year 2,458,435 board feet of lumber was manufactured and 2,569,908 board feet shipped from the mill. To June 30, 1924, a total of 23,104,583 board feet of lumber, including the output from the former mill site at Canyon Ranch, has been manufactured by the City's Mill.

Mather Vacation Camp

During the months of July and August, 1924, a vacation camp is to be operated by the Playground Commission of the City and County of San Francisco at Mather, using for the purpose the cabins and other facilities of the sawmill camp. As the mill will not be in operation, the entire camp has been placed at the disposal of the Commission, except a few buildings which are necessarily reserved for the use of the sawmill caretaker, Hetch Hetchy Railroad station agent and section men, etc.

Mountain Division Aqueduct Tunnels

Under the head of "Mountain Division Aqueduct Tunnels" are included the tunnels extending from the headworks at Early Intake Diversion Dam to Priest Reservoir, a length of 18.9 miles of tunnel. The excavation of these tunnels was completed during the fiscal year and the rate of progress being made in constructing the concrete lining is such that the tunnels will be ready for service early in 1925.

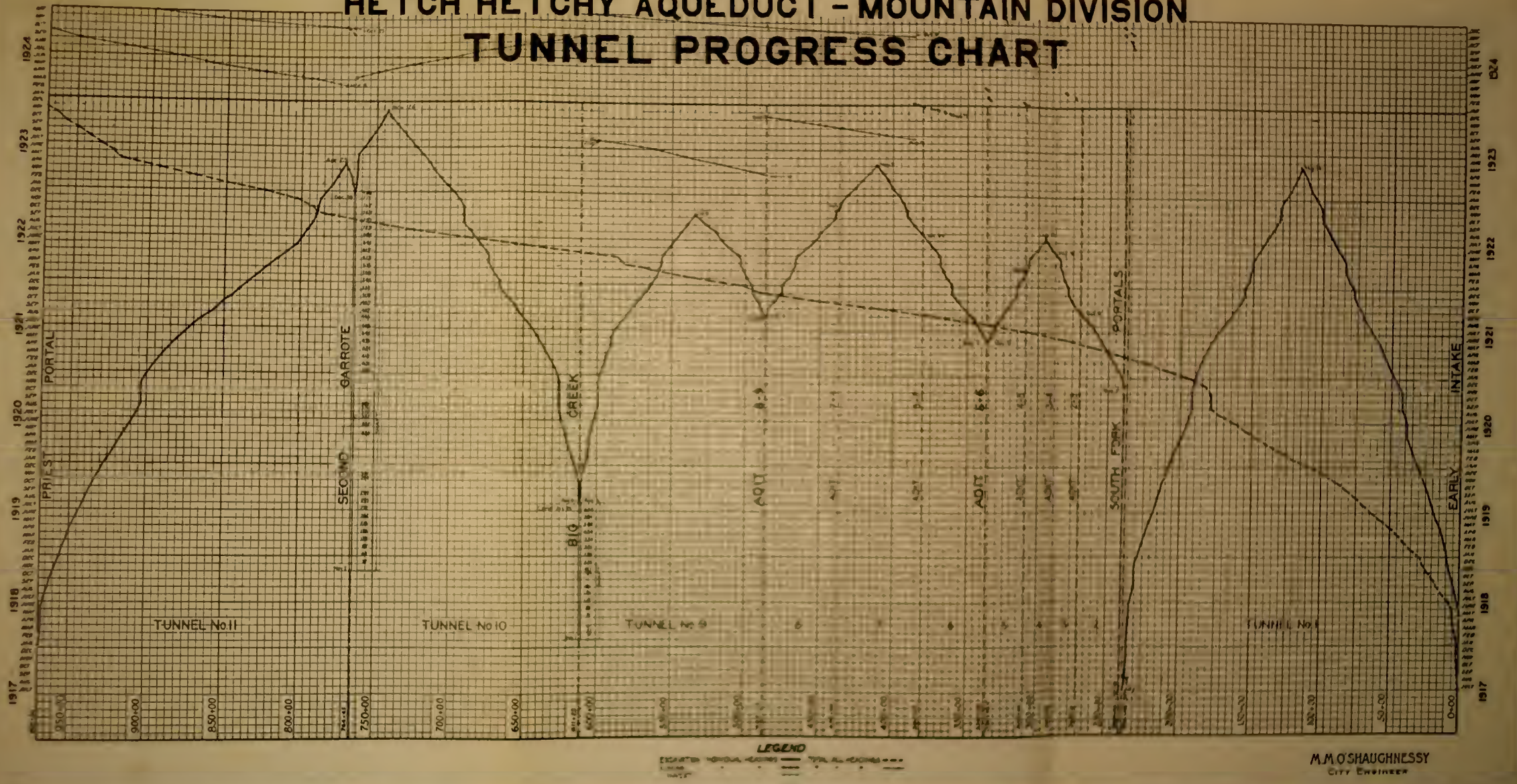
The 18.3 miles of tunnel included within the limits of Contract No. 77-C extends from an adit about 0.6 mile downstream from the Early Intake Dam to Priest Reservoir. Of this length, 15,080 feet was excavated by the City previous to the commencement of contract work.

A section of tunnel 3,051 feet in length, connecting the headworks at the dam to the above-mentioned adit, is

DIVISION
EARLY INTAKE
SOUTH FORK PORTALS
ADIT
TUNNEL No. 1
May 24
Nov. 0
1917
1918
1919
1920
1921
1922
1923
1924
0+00
50+00
100+00
150+00
200+00
250+00
M.M.O'SHAUGHNESSY
CITY ENGINEER

HETCH HETCHY AQUEDUCT - MOUNTAIN DIVISION

TUNNEL PROGRESS CHART



M.M.O'SHAUGHNESSY
CITY ENGINEER

being constructed by City forces not connected with Contract No. 77-C, and is now nearly completed.

Tunnel Excavation:

Excavation in the tunnels covered by Contract No. 77-C was completed during the fiscal year. This work of excavation comprised the drifting of 81,747 feet of tunnels, and the enlargement of a considerable part of the 15,080 feet drifted by the City previous to the commencement of contract work; this enlargement being occasioned by the decision to leave the tunnels unlined in the hard, sound rock and make the waterway larger to compensate for the greater frictional resistance of rough rock surfaces retarding the flow of water. The two headings, extending respectively east from Second Garrote and west from Big Creek, were the only headings in which excavation was carried on during the year, all others having been previously connected.

The excavation of the connecting tunnel adjacent to the headworks was commenced and carried to completion during the fiscal year, on a day labor basis.

The length of tunnel excavated in each heading of the Mountain Division is as tabulated below:

Aqueduct Tunnel Excavation, Mountain Division.

Heading	To be lined or unlined	Previous to July 1, '23 Ft.	July 1, '23, to June 30, '24 Ft.	Total to June 30, '24 Ft.
Early Intake Adit to Priest Reservoir:				
Early Intake	Unlined	11,632	.....	11,632
South Fork, East	Unlined	12,059	.....	12,059
South Fork, West	Unlined	5,599	.....	5,599
Adit 5-6, East	Unlined	4,257	.....	4,257
Adit 5-6, West	Unlined	5,010	.....	5,010
	Lined	2,425	.....	2,425
Adit 8-9, East	Lined	7,568	.....	7,568
Adit 8-9, West	Lined	4,772	.....	4,772
Big Creek, East	Lined	7,700	.....	7,700
Big Creek, West	Lined	11,185	1,951	13,136
Second Garrote, East	Lined	632	1,548	2,180
Second Garrote, West	Lined	642	.....	642
Priest	Lined	19,847	.....	19,847
Total		93,328	3,499	96,827
Connection from Early Intake Headworks to heading from Early Intake	Unlined	.....	2,647	2,647
	Lined	.....	404	404
Total		.....	3,051	3,051
Totals–Early Intake Headworks to Priest Portal		93,328	6,550	99,878

Note: The tunnel from Early Intake Headworks connects with the heading from Early Intake Adit 473 feet from the portal of the latter. The net length of aqueduct tunnels from Early Intake Headworks to Priest Portal is therefore 99,405 feet or 18.8 miles.

Following is a brief description of the work of tunnel excavation and some incidental work as carried on during the year from the various camps from Early Intake to Priest.

Early Intake: Under Contract No. 77-C, 3,300 feet of small diameter tunnel previously driven by the City was enlarged to the necessary dimensions for unlined tunnel. Concrete lining was placed in several short sections at seams or where the rock required support, the aggre-

gate amount of such lining being 475 lineal feet. This has been satisfactorily completed and the track, pipes and wiring removed from the heading. The camp and equipment released on completion of contract work at this point were taken over by the City for use on the non-contract work of constructing the diversion dam, headworks and the connecting tunnel.

As previously mentioned, this latter tunnel, 3,051 feet long was driven by City forces during the fiscal year to establish connection between the Early Intake headworks and the tunnel already driven. The junction of the new and old tunnels is 473 feet in from the portal of the original tunnel, which served as an adit for the construction of the new tunnel. Excavation eastward from the junction point was commenced October 2, 1923. The east portal, just upstream from the south abutment of the diversion dam, was faced at the same time and advanced 201 feet, when the heading was shut down and work concentrated at the westerly heading. The diversion tunnel is unlined, except for a few short stretches, and has a cross-sectional area of 166.5 square feet. An exceptional rate of progress was maintained, 531 feet being driven in granite formation during the month of March. The tunnel was holed through on April 13, 1924. Several soft seams were encountered, which required lining, and after scaling and removing pipe, etc., concrete operations were begun. Of the 404 feet total length of lining required, 300 feet is completed.

South Fork: Thirty-five hundred feet of tunnel originally driven to the small section for lining, was widened to the dimensions for unlined tunnel, and a section of 300 feet at the East Portal was trimmed preparatory to lining.

The South Fork of the Tuolumne River is to be spanned by 225.5 feet of steel pipe, 9 feet 6 inches in diameter, supported on concrete piers. Excavation is now in progress for the foundation of these piers.

Adit 5-6: The tunnels east and west from this camp were scaled of loose rock in the roof and sections to be lined were trimmed to the neat line.

Adit 8-9: Trimming was completed from this camp August 13. The camp remained in use in connection with lining operations for about three months longer. All equipment has now been removed and the camp is being dismantled.

Big Creek Shaft: Though somewhat hampered by the increasing flow of water, good progress was maintained in advancing the west heading 1,951 feet and the tunnel was connected with the Second Garrote east heading November 26th. This completed the excavation in the tunnels between Early Intake and Priest, except the section immediately adjacent to the diversion dam. The tunnel was then trimmed preparatory to lining and turned over to lining operations in March.

Second Garrote Shaft: The east heading was steadily advanced from the beginning of the fiscal year, a progress of 1,548 feet being made to November 26, 1923, the date of holing through. The tunnel was then trimmed and made ready for concrete lining.

Priest Portal: The excavation work at this camp comprised trimming the tunnel to the neat line of excavation. This was completed and lining operations begun on March 6th.

Tunnel Lining:

Placing of the concrete lining in sides and arch of the Mountain Division tunnels has continued throughout the year. The work was carried on with collapsible forms, concrete guns, and portable concrete mixers from central plants at Big Creek Shaft and Priest Portal. Sides and arch of 33,576 feet of tunnel were lined using a total of 60,430 cubic yards of concrete, averaging 1.8 cubic yards

per lineal foot. To date 41,007 lineal feet of sides and arch have been placed using 72,522 cubic yards of concrete. The location of lining constructed and the rate of progress of this work are shown on the accompanying tunnel progress chart. No invert lining has yet been placed.

Lining from Big Creek Plant: With the exception of a few short shutdowns, lining operations were carried on continuously from the Big Creek shaft plant, a total of 22,494 feet of tunnel being lined in sides and arch during the fiscal year. The methods and equipment used in this work were described in detail in the annual report of 1922.

A fire on July 29th destroyed the screen house, conveyor belt, etc., of the Big Creek crushing plant and the sand situation became very acute due to the resulting delay in the manufacture of artificial sand (rock crushed very fine) for the lining.

Sides and arch were placed from Adit 8-9 westward to Big Creek Shaft. This portion was completed August 8, after which the portable lining plant was moved to Adit 6-7 and from that point worked westward to Adit 8-9. This second stretch was completed November 13. The plant was then moved to Adit 2-3 and short stretches of tunnel aggregating 1,732 feet, where the ground required support, were lined.

Adits 5-6 and 8-9 are being left open until track and pipes are removed from the completed tunnels. All other adits have been closed with concrete plugs, thirty inch manholes have been provided in the concrete plugs, through which access to the aqueduct may be had when necessary. In some cases the portion of the adit from the adit portal to the closing plug have been lined to prevent caving and consequent blocking of the passageway to the manholes. In Adits 5-6 and 8-9 manholes five feet in diameter will be provided, in order to permit running in a small car if necessary to transport materials for repairs in the tunnel.

This adit work was completed in March and the lining plant moved to Second Garrote, where the lining of sides and arch was begun on April 11, working eastward toward Big Creek. There remained after June 30, 1925, 8,927 feet of sides and arch yet to be placed between Second Garrote and Big Creek.

Lining from Priest Portal Plant: As soon as the tunnel between Priest Portal and Second Garrote Shaft was trimmed, the portable concrete plant, consisting of 400 feet of Blaw collapsible type forms, a 24 inch Webb concrete gun, a No. 14-S Ransome mixer and a 120 foot portable belt conveyor, was assembled in the tunnel and the lining of sides and arch began at Second Garrote shaft on March 6th.

Good progress has been maintained and there remains 9,407 feet of sides and arches yet to be completed in this section; 11,082 feet have been lined since operations started, using 18,074 cubic yards of concrete, or 1.63 cubic yards per foot.

The equipment and methods used in lining the Priest-Second Garrote section of the aqueduct are much the same as described in connection with the Big Creek lining operations in the last preceding annual report. The sand, rock and cement are stored at the portal and the measured dry aggregate is loaded into bottom dump cars having three compartments, each compartment holding one three-sack batch. A train of seven cars or twenty-one batches is hauled by an electric storage battery locomotive to the point where lining is in progress. The dry concrete is dropped from the cars, a batch at a time, onto the portable belt conveyor and conveyed to the mixer where water is added. After thorough mixing, the batch is discharged into the Webb concrete gun and shot into place back of the steel forms by compressed air.

In the vicinity of Second Garrote shaft where considerable water bearing seams were encountered, little diffi-

culty was experienced in taking care of the water flow during lining operations. Where possible, holes were drilled directly into the flowing seam and the water drained through the forms into the tunnel. Where this was not possible, small holes were drilled in the rock around the water bearing seams and wooden plugs were driven into the holes. To these plugs sheet tin was nailed securely in such a position that the water would drain to one corner where it was led out through a pipe.

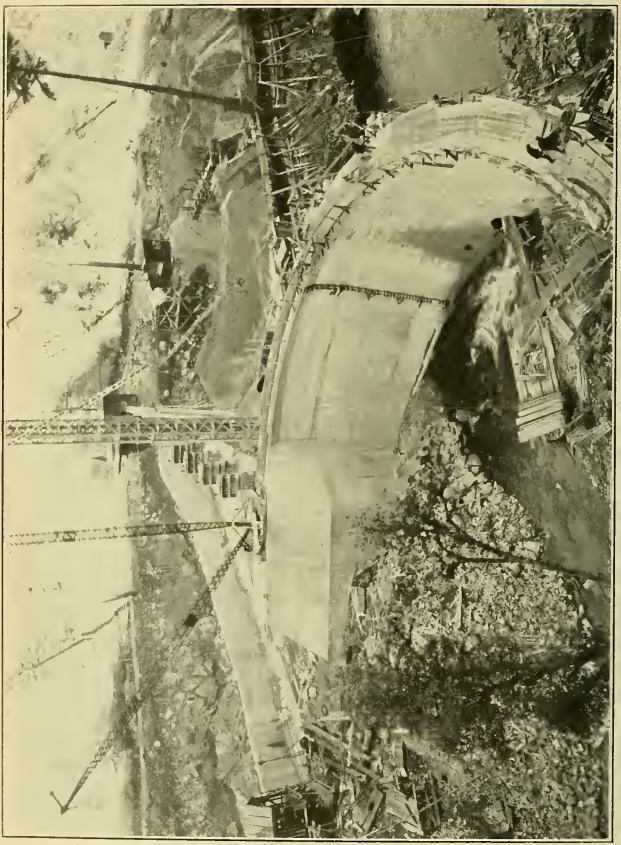
Early Intake Diversion Works

Diversion Dam and Spillway:

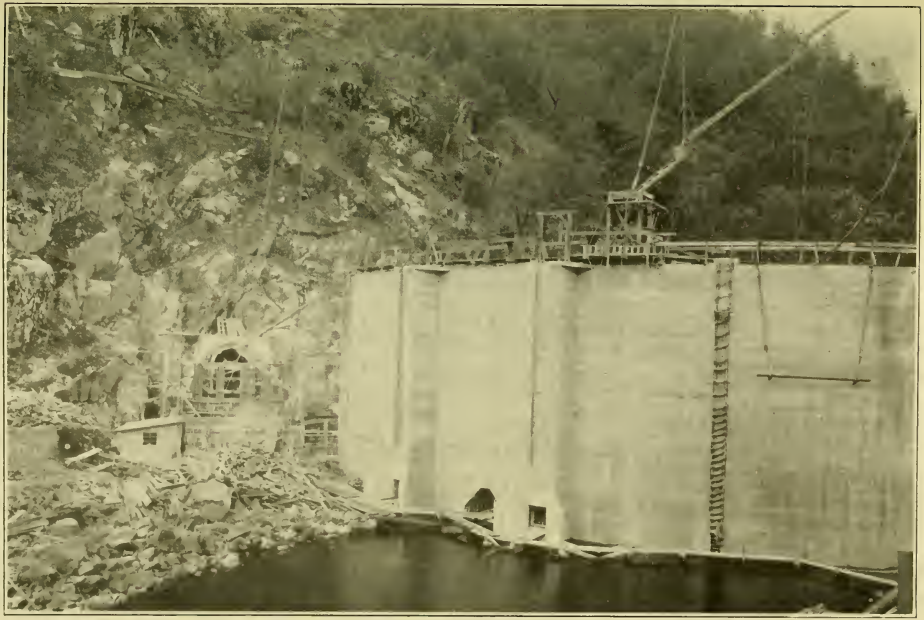
Work has been carried on continuously on the Early Intake diversion dam and appurtenances. A massive concrete block containing 3,611 cubic yards of concrete, which forms the north abutment of the arch dam, was completed November 13. Excavation on the dam proper started on September 23, 1923, and bedrock was exposed throughout on November 5. This involved the moving of 5,000 cubic yards with a maximum cut of 25 feet in the center of the stream. Concrete pouring in the foundation of the arch was started on November 10 and finished to elevation 2,310 or approximately the bed of the stream, on November 25. The problem of stream diversion in the construction of the foundation of the dam was rendered simple by controlling the stream flow at O'Shaughnessy Dam. The construction of the spillway, an open channel with reinforced concrete lining passing the north end of the dam, was vigorously prosecuted. The excavation for the spillway, comprising 34,200 cubic yards, was completed on November 27. To date 4,500 cubic yards of concrete have been placed in the spillway and work is now progressing on the spillway lip. Work on the dam proper will be resumed and completed during the low water stage of the river.

Clearing Reservoir:

All timber within the flow line of the reservoir area above the Early Intake diversion dam was removed and



EARLY INTAKE DIVERSION DAM AND SPILLWAY.
HETCH HETCHY WATER SUPPLY PROJECT.
Downstream face during construction.



EARLY INTAKE DIVERSION DAM AND AQUEDUCT TUNNEL.
HETCH HETCHY WATER SUPPLY PROJECT.
Upstream face of the dam and tunnel portal during construction.

burned. This involved clearing approximately 15 acres of land.

Moccasin Power Development

Priest Dam:

Priest Dam and Reservoir are described in the report of 1921-22. The earth fill for the dam was completed in August, 1923. Riprap on the upstream face, consisting of rock excavated from the Priest-Moccasin tunnel, was completed in October.

The spillway, an open canal around the east end of the dam, was excavated with a hydraulic monitor in a formation of clay and decomposed granite. The canal is 350 feet long, 20 feet wide at the bottom, and has side slopes of 1 vertical to ½ horizontal. The volume of excavation involved was 7,066 cubic yards. It is lined with concrete of 6 inches minimum thickness in the bottom, and has side walls 5 feet high. The lining was completed in November.

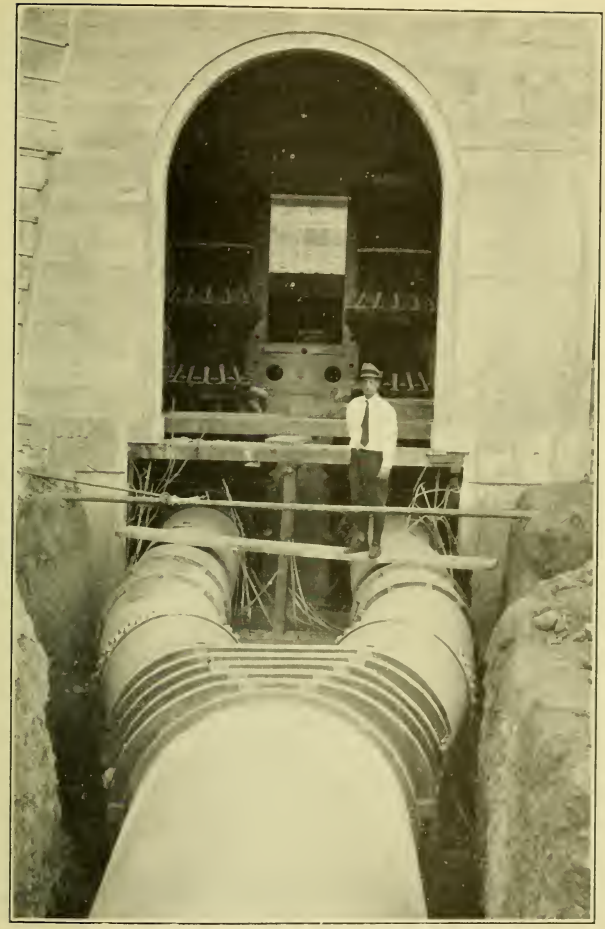
The following table shows the quantities involved in the Priest Dam:

Priest Dam—Quantities

Upstream rock fill (tunnel dump)	1,763 cu. yds.
" hydraulic fill	247,656 " "
" earth fill (steam shovel)	85,616 " "
Downstream rock fill (tunnel dump)	102,713 " "
" earth fill (steam shovel)	264,981 " "
Riprap upstream	14,554 " "
Total earth and rock	717,283 cu. yds.
Core wall concrete	17,043 cu. yds.
Spillway excavation	7,066 " "
" concrete lining	607 " "
Outlet tunnel length	982 feet
" " concrete lining	1,494 cu. yds.
" tower concrete	505 " "

Power Tunnel:

Priest Reservoir connects with the Moccasin penstocks by means of a tunnel through the ridge northwest of the reservoir. From the reservoir the distance is 5370 feet to a surge shaft from which three parallel tunnels, each 535



PENSTOCK PIPE AND Y, MOCCASIN POWER PLANT.
HETCH HETCHY WATER SUPPLY.

Showing one of the 57-inch steel pipe lines branching into two 48-inch lines leading into Moccasin Power House.

feet long, lead to an open cut on the hillside above the power plant.

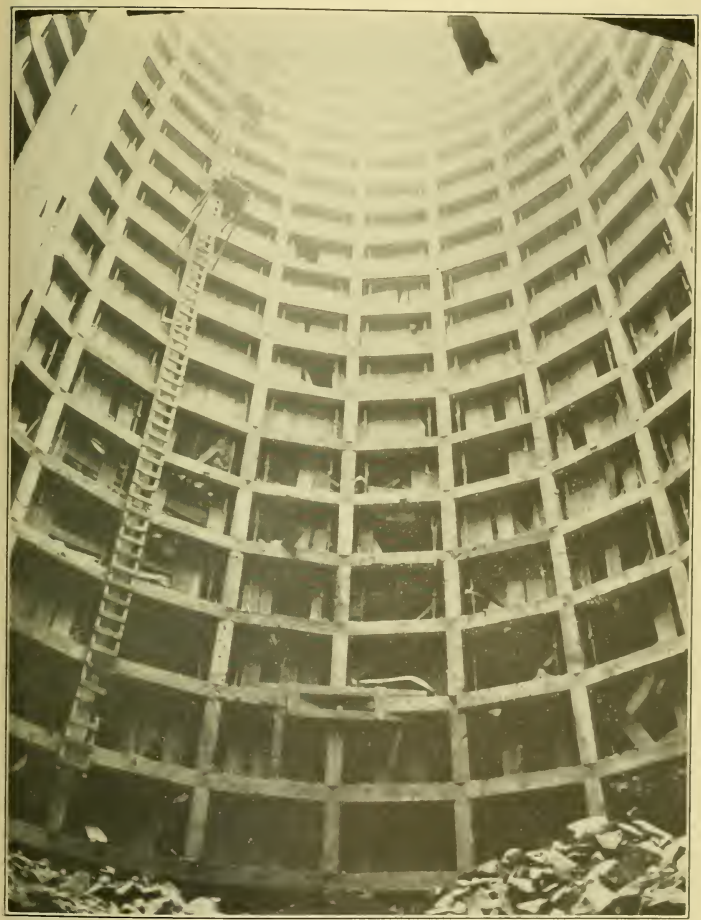
The main tunnel is of horseshoe section, concrete lined, 13 feet in height and width inside of lining. The concrete lining will be nine inches minimum thickness, but the average thickness will be much greater as sections of the tunnel will be timbered. The steel penstock pipes will begin at the surge tank and be laid through the three parallel tunnels. When the pipes are in place the space surrounding them will be filled completely with concrete. The pipes in the tunnel will be 104 inches in inside diameter.

The tunnel from the reservoir to the surge tank was holed through on October 8. It has been trimmed and is ready for lining. Wooden forms for the lining, covered with 24 gauge sheet metal, are being constructed on the work, together with the necessary conveyors, etc., for the concrete plant. A 21-S Ransome mixer and a 30-inch Webb concrete gun are on the site and the placing of concrete lining will begin July 21, 1924.

The surge chamber will be a concrete lined shaft 40 feet in diameter inside of lining, and 159.5 feet in depth to tunnel grade, of which depth 112 feet will be beneath the ground surface. Excavation of the shaft was completed December 18th, 1923.

Excavation in the last of the three parallel tunnels from the surge tank in which the 104-inch penstock pipes are to be placed, was completed in January, 1923, and all three are now ready for the penstock pipes to be placed in them.

At the west portal the crushing plant, making concrete aggregate from the tunnel spoil, has been operating continuously and there is sufficient material on hand to line the large tunnel for a distance of 2,100 feet east of the surge tank. Aggregate for lining the remainder of the tunnel will be obtained from the Priest Portal plant.



SURGE CHAMBER—MOCCASIN POWER DEVELOPMENT.
HETCH HETCHY WATER SUPPLY.
Showing timbering and lagging in shaft previous to placing concrete lining.

Moccasin Penstocks:

A camp of standard construction, accommodating 150 men, was constructed adjacent to the railroad right of way at Cavagnaro for the crews engaged in the penstock installation.

Excavation has been completed for all of the twenty concrete anchors along the penstock line and twelve anchors have been poured, requiring 4,144 cubic yards of concrete and 59.4 tons of reinforcing steel. Practically all of the intermediate saddles to support the pipe between anchors have been constructed, involving 1,050 cubic yards of concrete.

The actual placing of the penstock pipes was commenced March 1, 1924, starting at the Y branches at the power plant. All pipe thus far placed is heavy welded steel pipe furnished by M. W. Kellogg Company under Contract No. 91-G. This pipe is in sections 30 feet long. To date 209 lengths or about 6,270 feet of pipe, weighing 2,227 tons, have been placed in the four penstock lines.

Over 90 per cent of the riveted steel portion of the penstock pipes made by the Western Pipe and Steel Company of California, under Contract No. 91-A, has been delivered to the pipe yard at Moccasin power plant. Work is proceeding rapidly under Contract No. 97 on the construction of the three 104-inch butterfly valves which are to be placed in the penstock lines at the outlet of the tunnels emerging from the surge shaft.

Moccasin Power Plant:

During the fiscal year complete deliveries were made of the four 25,000 h. p. impulse water wheel units by the Pelton Water Wheel Company under Contract No .79-A. The Coffin Valve Company of Boston also completed and delivered eight 36-inch hydraulically operated gate valves, under Contract 79-B. These valves have been set just outside of the power house in the penstock lines and will

MOCCASIN POWER HOUSE—HETCH HETCHY WATER SUPPLY PROJECT.
Exterior view during construction.

control the flow of water to the Pelton Water wheels. Each water wheel unit includes two wheels, one on each end of the generator shaft, a valve being provided for each wheel.

The General Electric Company has delivered, complete, four 20,000-kv-a., 11,000-volt, 3-phase, 257 r.p.m. alternating current generators for direct connection to the water wheels. These were supplied under Contract No. 80. As a part of this contract, there were supplied also four 140- kw., 250-volt direct connected exciters, and one 300-kw., 1,800 r.p.m motor driven auxiliary exciter set.

The Westinghouse Electric and Manufacturing Company to which Contract No. 81 was awarded on August 18, 1922, has completed the delivery of all of the transformers, oil switches, and switchboards necessary to transform and control the output of the power house.

The Union Construction and Dry Dock Company completed under contract the erection of the structural steel frame for the power house building during the fall of 1923. The City's forces constructed the building of reinforced concrete walls and roof. At the present time the power house building is completed with the exception of the installation of the roof tiling, the sash, glass, and interior finish. The tiling has been contracted for and the sash is on the site of the work. The exterior of the building has been coated with stucco of a tone blending most harmoniously with the surrounding landscape. The interior of the building has been painted white which offers not only a clean appearance but is an effective aid in lighting the building, particularly in the basement where the lighting is entirely artificial. All of the piping and auxiliary work in the basement has been completed.

The installation of the electrical equipment was commenced early in the year and is now well under way. The 135-ton capacity electric crane furnished by Pawling and Harnischfeger Company, under Contract No. 70, was de-

MOCCASIN POWER HOUSE—HETCH HETCHY WATER SUPPLY PROJECT.
Interior view during installation of water wheels and generators.

livered and installed and has been used in the installation of all the heavy machinery within the power house. This work of installation has been expeditiously prosecuted by the City's forces. The personnel in charge of the work has not only been very capable, but also very energetic and efficient.

Outside of the power house there has been constructed a small building, housing the control of the oil storage which is underground. This building contains pumps, filters and testing equipment.

The year has seen the completion of six cottages for power house operators and employees. In addition to the cottages, a six car garage and a school house have been constructed. These buildings are at present occupied by the men in charge of the several branches of the construction work at the plant. There is also under construction a clubhouse building which will provide living quarters for single men and a large living room which can be used as a community center for the power plant employees and their families.

Transmission Line:

The construction of the transmission line has been vigorously prosecuted throughout the year and progress is such as will insure its completion as far as Newark coincidently with the completion of the power plant. Work on the foundations and installation of the steel stubs for the towers has been under way and the foundations for all towers will be completed by the time the tower steel is delivered, permitting concentration of effort on the erection of the steel. The transmission line construction is being prosecuted from nine camps.

The following contracts for transmission line equipment and material have been awarded:

Contract No. 78, to the Anaconda Copper Mining Company for furnishing and delivering 177 miles of hemp cored

copper cable at an estimated cost of $195,000.00. All of the conductor required at the present time has been delivered and the copper necessary to complete the line into San Francisco has been manufactured and is in storage at the mill;

Contract No. 89, covering the furnishing and delivering of steel reinforced aluminum cable by the Aluminum Company of America. The total cost of this work was $388,299.68. All of this material is on the ground ready for distribution along the transmission line;

Contract No. 98, for furnishing and delivering electric transmission line insulators awarded on November 20, 1923, to the Westinghouse Electric & Manufacturing Company. This involves the furnishing of approximately 27,000 standard suspension units and 12,000 heavy duty suspension units, at a cost of approximately $95,000.00. A considerable portion of this material has been tested and delivered. The balance of it will be forthcoming in ample time to meet the construction requirements;

Contract No. 99, covering the furnishing and delivering of electric transmission line towers, awarded on January 11, 1924, to the Pacific Coast Steel Company. These towers are of galvanized structural steel, a total of 507, including 392 standard towers, 95 heavy duty towers, 5 switch towers, 12 transposition towers and 3 special river crossing towers. Work on this contract has been delayed by the contractors and no towers will be delivered before the middle of July, 1924. The contractor has, however, furnished all of the necessary steel stubs and work on the installation of these in the concrete foundations has been carried on since March;

Contract No. 103. The hardware for use in connecting the cables to the insulators and towers is being purchased under this contract from the Westinghouse Electric & Manufacturing Company and the Western Electric Company, each furnishing a portion of the material required.

The line under construction will extend from the Moccasin Power House to a point on the east side of San Francisco Bay near Newark, the length of this section of the line being 98½ miles. This line will consist of two three-phase circuits (six wires) supported on steel towers. The transmission line right of way, as far as practicable, is combined with the right of way required for the water conduit; where this is the case the width of the strip acquired is 110 feet, elsewhere it is 100 feet wide.

The towers, as designed, consist of four angle iron legs laced together with lighter angles. The base of each tower is 18 feet square. The towers are 97 feet in height, the lowest arm being 62 feet above the ground. The upper and lower arms will carry the conductors of the two circuits spaced 24 feet apart, while the conductors at the middle arm will be spaced 28 feet. The spans are such that the towers average five per mile; across the level valleys, the spacing is approximately 950 feet; in the hilly sections it is somewhat greater. In a number of location the spans will be over 2,000 feet.

The aluminum conductors will be installed from the Moccasin Power House to a point nine miles east of the present westerly terminus, from which point hemp cored copper conductors will be used around San Francisco Bay. The aluminum conductors are rated at 397,500 circular mils with a copper equivalent of 250,000 circular mils. The copper conductors are made up in the form of a 425,000 circular mils concentric stranded cable with the seven center strands replaced with a saturated hemp core, resulting in a conductor of a copper cross-section of 345,000 circular mils.

Lower Cherry River Power System

The 3,000-kv-a power plant of the Lower Cherry system, built in 1917 to furnish electric power for construction purposes in the upper division of the Hetch Hetchy project, was in service without interruption during the

fiscal year. The total energy generated was 24,637,300 kilowatt hours, of which approximately 40% was used at the various construction plants, nearly 40% sold to the Pacific Gas & Electric Company and the balance consumed chiefly in transmission losses which are relatively heavy in such service as is required of this plant.

Statistics of Operation of Lower Cherry River Power System

(July, 1923, to June, 1924, inclusive)

Power generated and received:	Kilowatt-hours
Generated at Lower Cherry Plant	24,637,300
Metered in from P. G. & E. Co.—Priest	16,000
" " " —Moccasin	894,083
Total	25,547,383
Disposal of Power:	
Used by City	10,012,368
Metered out to P. G. & E. Co.—Priest	10,024,000
Metered out to miscellaneous consumers	9,262
Transmission losses and unaccounted for	5,501,753
Total	25,547,383

Bay Development

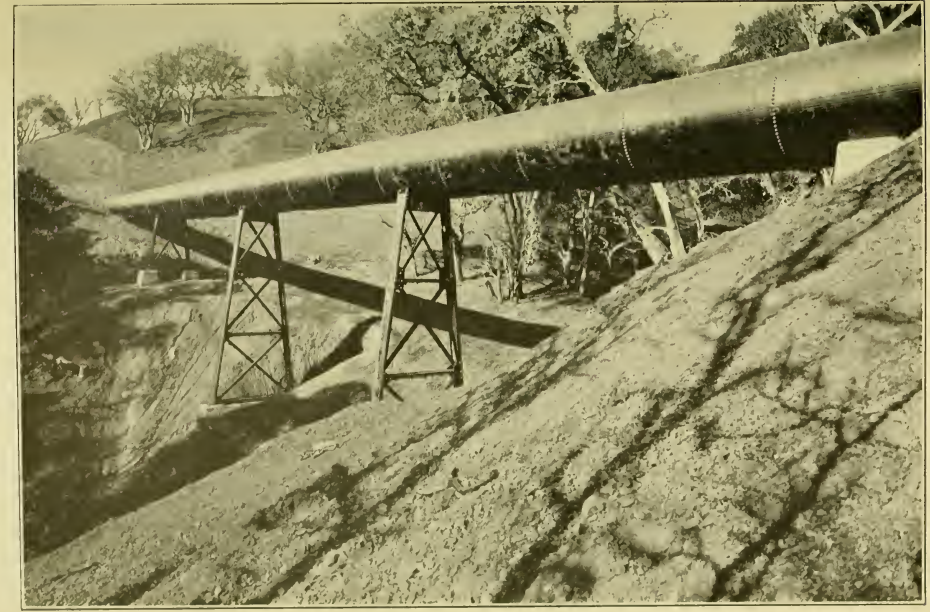
Bay Crossing Pipe Line:

The Bay Crossing pipe line will extend from a point near Irvington, Alameda County, to the easterly end of the Pulgas Tunnel. The pipe line is 19.4 miles long, not including the submarine siphons at Newark Slough and Dumbarton Strait. The pipe is riveted steel, 5 feet nominal diameter, the plate thickness varying from 5/16 inch to 7/16 inch. The total weight of steel will be about 17,000 tons.

The right of way varies in width from 60 to 100 feet, and is ultimately to contain three pipes of 6 ft. 4 inch nominal diameter each.

Beginning near Irvington at elevation 52 feet, the pipe line is buried in the ground for six miles, gradually descending to the edge of the salt march west of Newark, from which point it will be carried over the marsh on a

PIPE LINE—BAY CROSSING DIVISION—HETCH HETCHY AQUEDUCT.
60-inch riveted steel pipe line through Redwood City.



PIPE LINE—BAY CROSSING DIVISION—HETCH HETCHY AQUEDUCT.
60-inch riveted steel pipe on steel bents in Cordilleras Canyon, San Mateo County, California.

timber trestle 1.7 miles to Newark Slough. The slough will be crossed by a submarine siphon of 42 inch cast iron pipe, about 400 feet in length. From Newark Slough to the east shore of Dumbarton Strait, 1.4 miles, the 5 foot steel pipe will continue over the marsh on timber trestle. The navigable channel at Dumbarton Strait will be crossed by another 42 inch submarine siphon nearly 2,800 feet long, ending at a concrete caisson 81.5 feet in diameter in the Bay. From the caisson the steel pipe will be carried on a steel bridge 3,875 feet to the west shore of the strait, thence on trestle 2,700 feet to the Bay-Pulgas pump station. From this point west the pipe is buried, continuing at a low elevation through Redwood City. The westerly 2.1 miles of the line passes through hilly country in and near Cordilleras Canyon, and the pipe is alternately buried and supported on steel bents and concrete piers over the gullies. In this section it rises to an elevation of 290.5 feet at the west end where it connects with Pulgas Tunnel.

The pipe is being manufactured and laid by the Western Pipe and Steel Company under Contract No. 90, for an estimated price of $2,231,661.25. Pipe laying was begun on the westside of the Bay on October 20. To date 14.3 miles of pipe have been laid, which nearly completes that portion of the pipe line which is not on trestle or bridge.

Dumbarton Strait Bridge:

The bridge which will carry the pipe lines over the shallow water on the west side of Dumbarton Strait consists of 36 steel spans supported on 37 concrete piers.

Contract No. 95 for the construction of the piers was awarded October 19th to Healy-Tibbitts Construction Company for an estimated price of $1,192,483.50, but it was some months subsequently before the Board of Supervisors appropriated the necessary funds.

Piers: Except for the east end pier, each pier consists of two vertical cylinders of reinforced concrete, con-

Hetch Hetchy Water Supply of the City and County of San Francisco, California.

CONTRACT NO. 95.

SUBSTRUCTURES FOR THE STEEL BRIDGE ACROSS DUMBARTON STRAITS.

Record of Bids Received.

BIDS RECEIVED OCT 17 1923
CONTRACT AWARDED OCT 19 1923
TO HEALY TIBBITTS CONSTRUCTION CO
FOR $ 1192483.50

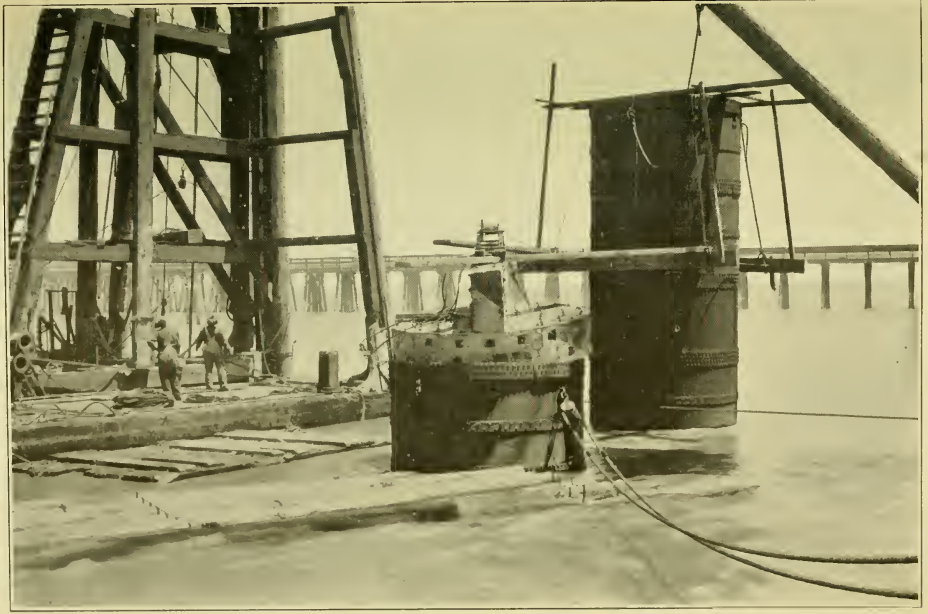
Item No.	Item	Quantity Estimated	Unit	No. 1 Bidder's Name and Address: SAN FRANCISCO BRIDGE CO — Total bid on entire contract. Unit Price Bid Dollars Cents	No. 1 Total Dollars Cts.	No. 2 Bidder's Name and Address: HEALY TIBBITTS CONSTRUCTION CO — Total bid on entire contract. Unit Price Bid Dollars Cts.	No. 2 Total Dollars Cts.
1.	MUD EXCAVATION FOR PIERS	20,000	CU. YDS	5 00	100,000 -	1 48	29,600 -
2(a)	FURNISHING & DELIVERING PILES	140,000	LIN. FT	34	47,600 -	29	40,600 -
(b)	DRIVING EACH PILE	2,350	PILES	12 00	28,200 -	17 12	40,232 -
(c)	CUTTING OFF EACH PILE, IN THE DRY	1,500	PILES	50	750 -	84	1,260 -
3.	FURNISHING, DELIVERING & PLACING TREMIE CONCRETE UNDER WATER	3,250	CU. YDS	60 00	195,000	45 75	148,687 50
4.	FURNISHING, DELIVERING & PLACING CONCRETE IN FORMS, IN THE DRY, IN PIERS						
(a)	HEIGHTS BETWEEN 0 AND 45 FT.	1,250	CU. YDS	48 00	60,000	47 82	59,775 -
(b)	" " 46 - 50 '	2,200	" "	53 00	116,600	54 16	119,152 -
(c)	" " 51 - 60 '	3,350	" "	58 00	194,300	59 88	200,598 -
(d)	" " 51 - 75 '	800	" "	71 00	56,800	66 23	52,984 -
5.	FURNISHING, DELIVERING & PLACING. REINFORCING STEEL	600,000	POUNDS	07	42,000	05½	33,000 -
6.	PLACING METAL WORK FURNISHED BY CITY	10,000	"	10	1,000	05	500 -
7.	MUD EXCAVATION FOR CAISSON	8,250	CU. YDS	5 00	41,250	1 48	12,210 -
8(a)	FURNISHING & DELIVERING PILES	60,000	LIN. FT	34	20,400	29	17,400 -
(b)	DRIVING EACH PILE	850	PILES	12 00	10,200	16 80	14,280 -
(c)	CUTTING OFF EACH PILE IN THE DRY.	600	"	50	300	84	504 -
9.	FURNISHING, DELIVERING & PLACING TREMIE CONCRETE UNDER WATER	2,200	CU. YDS.	55 00	121,000	46 08	101,376 -
10.	FURNISHING, DELIVERING & PLACING CONCRETE IN FORMS IN THE DRY, IN THE CAISSON	5,800	" "	35 00	203,000	54 25	314,650 -
11.	FURNISHING, DELIVERING & PLACING REINFORCING STEEL	35,000	POUNDS	06½	2,275	05½	1,925 -
12	PLACING METAL WORK FURNISHED BY CITY	75,000	"	10	7,500	05	3,750 -
	TOTAL				1,248,175		1,192,483 50
	AMOUNT OF CERTIFIED CHECK				125,000		120,000

nected by horizontal beams. The program carried out in the construction of these piers is as follows: A cofferdam of wood or steel sheet piling is driven around the site of the pier. The mud within the cofferdam is then excavated to a depth of from 5 to 30 feet, depending on conditions, below the original mud line. Piles, varying in number from 52 to 60, are driven into the bottom of the excavation. The water within the cofferdam is then pumped out and the concrete foundation is poured. Forms are built for the upper part of the pier, and the remaining concrete is poured in the usual way. After the concrete has set, forms are stripped and the sheet piling is removed and used at a new location.

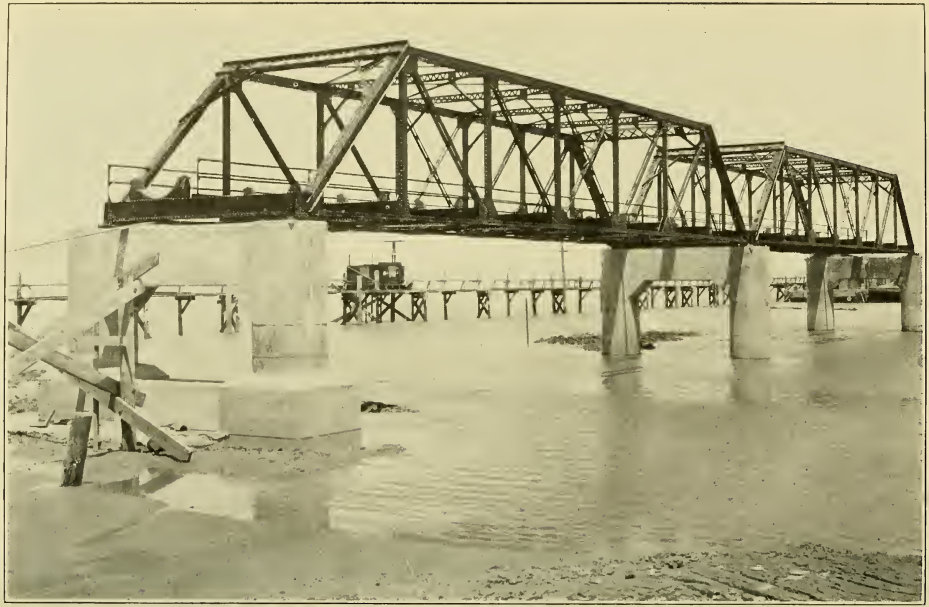
On two piers it was found impossible to pump out the cofferdam before placing the concrete, on account of excessive leakage around the bottom. In each of these cases a six foot layer of tremie concrete was poured under water, forming a foundation for the pier and sealing the cofferdam against leakage. After the tremie concrete had set, the cofferdam was pumped out and the remainder of the pier constructed.

On June 30, 13 of the 37 piers were completed and 6 were under construction.

Caisson: The east pier takes the form of a large concrete caisson in which connections will be made between the steel pipes on the bridge and the submarine siphons. It is hexagonal in plan, 40 feet in short diameter at the top and 81 feet 6 inches outside diameter at the base, and supported on piles. The bottom of the central chamber, 24 feet in diameter, will be about 27 feet below sea level, and will contain four vertical pipes forming the west end connections of the submarine siphons. Just below the mud line, four 42-inch cast iron pipes embedded in the concrete wall of the caisson will provide for connection to four 42-inch submarine pipes. Only one of these will be used at present. The other three are provided for future



DUMBARTON BRIDGE—BAY CROSSING DIVISION—HETCH HETCHY AQUEDUCT.
Steel cylinders used in construction of cofferdam for end pier.



DUMBARTON BRIDGE—BAY CROSSING DIVISION—HETCH HETCHY AQUEDUCT.
Standard piers and spans (Note saddles on which pipe is to be laid).

connection to the submarine lines which will be installed one by one as necessity arises. Piles for the foundation of the caisson and the surrounding cofferdam are now being driven. The total number of piles will be approximately 720.

Bridge Superstructure: Contract No. 93, for furnishing and erecting the steel bridge superstructure, was awarded August 17, 1923, to the United States Steel Products Company for the estimated sum of $272,160.00. The 36 spans are each 105 feet long between supports and the designed to accommodate two steel pipes of 6 foot 4 inch nominal diameter. The weight of steel in the bridge will be approximately 1,761 tons. The spans are riveted up at San Francisco, floated to the bridge on barges and lowered into place with hydraulic jacks. To June 30, 1924, 3 spans have been installed. The pipe is to be supported on the bridge by redwood saddles spaced 15 feet apart. It will be anchored at alternate piers and provided with expansion joints at the remainder. A two foot walkway will be provided each side of the pipe.

Trestles for Pipe:

As previously stated, the pipe line will be supported on timber trestles for the 3.8 miles of its length which lies across the salt marches. Contract No. 96 for construction of the trestles was awarded April 30 to Leonard F. Youdall for an estimated price of $167,645, and pile driving construction is proceeding at two points simultaneously. The trestle requires nearly 1,000 two-pile bents spaced in general 20.56 feet apart. Several concrete anchors are included in the contract.

Submarine Siphons:

The navigable channel of Dumbarton Strait and the deeper water adjacent to the channel, with a total width of nearly 2,800 feet, and Newark Slough, about 400 feet wide, will be crossed by submarine siphons of cast iron

HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA.

CONTRACT NO. 93.

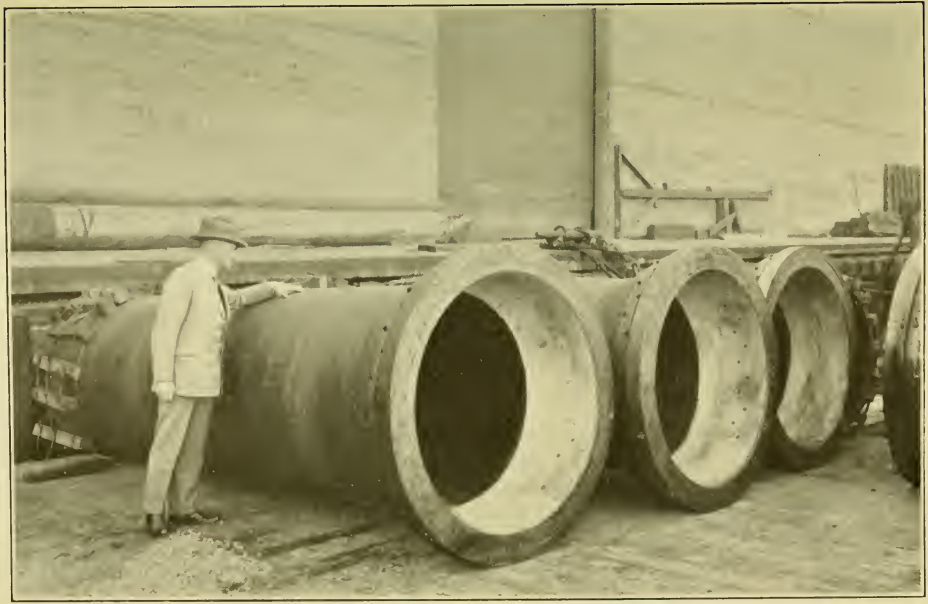
FOR FURNISHING, DELIVERING & ERECTING **STEEL BRIDGE SUPERSTRUCTURES** FOR BAY CROSSING PIPE LINE

RECORD OF BIDS RECEIVED

Bids received Aug. 15, 1923
Contract awarded Aug 17, 1923
to U.S. Steel Products Co.
under Prop. A for $ 272,162.00

	No. 1	No 2	No 3	No 4.	No 5	No 6
	Bidder's Name and Address	Bidders Name and Address	Bidders Name and Address	Bidders Name and Address	Bidders Name and Address	Bidders Name and Address
	MINNEAPOLIS STEEL & MACHINERY CO	HEALY TIBBITTS CONSTRUCTION CO.	BETHLEHEM SHIP BUILDING CORP	W. B. KYLE	J. G. WILLIAMS CONSTRUCTION CO.	U. S. STEEL PRODUCTS CO.
	$ 32000	$ 30000	$ 35000	$ 30000	$ 30000	$ 30000
	Total bid on entire contract	Total bid on entire contract	Total bid on entire contract	Total bid on entire contract	Total bid on entire contract	Total bid on entire contract
PROP. A	$ 299472.925	$ 281376.00	$ 324809.50	$ 287544.75	$ 289488.75	$ 272162.00
" B.	$ 263612.925	$ 252036.00	$ 288949.50	$ 253743.75	$ 255255.75	$ 239562.00

Item No.	ITEM	QUANTITY ESTIMATED	Unit	No. 1 Unit Price Bid Dollars Cts	No. 1 Total Dollars Cts	No 2 Unit Price Bid Dollars Cts	No 2 Total Dollars Cts	No 3 Unit Price Bid Dollars Cts	No 3 Total Dollars Cts	No 4. Unit Price Bid Dollars Cts	No 4. Total Dollars Cts	No 5 Unit Price Bid Dollars Cts	No 5 Total Dollars Cts	No 6 Unit Price Bid Dollars Cts	No 6 Total Dollars Cts
	PROPOSITION A.														
1	FURNISHING, DELIVERING ERECTING STEEL BRIDGE SPANS	2 880 000	lbs.	8 65	249 984 00	8 6	247 680 00	9 45	272 160 00	8 45	243 360 00	8 45	244 728 00	7 9	227 520 00
2a	FURNISHING & APPLYING PROTECTIVE COATING DIPPING PROCESS	326 000	SQ FT.	11	35 860 00	9	29 340 00	11	35 860 00	9 75	31 785 00	9 75	31 785 00	10	32 600 00
b	HAND PAINTING PROCESS	. .				NO BIDS RECEIVED									
3	FURNISHING, DELIVERING, PAINTING, ERECTING REDWOOD PIPE SILLS	288		23 10	6 652 80	7 00	2 016 00	26 00	7 488 00	20 00	5 760 00	22 00	6 336 00	21 50	6 192 00
4	FURNISHING, DELIVERING, PAINTING, ERECTING OREGON PINE WALKWAYS	58 ±	1000 FT B.M.	119 25	6 976 12 5	40 00	2 340 00	159 00	9 301 50	113 50	6 639 75	113 50	6 639 75	100 00	5 850 00
	TOTAL				299 472 925		281 376 00		324 809 50		287 544 75		289 488 75		272 162 00
	PROPOSITION B.														
1.	FURNISHING, DELIVERING ERECTING STEEL BRIDGE SPANS	2 880 000	lbs.	8 65	249 984 00	8 6	247 680 00	9 45	272 160 00	8 38	241 344 00	8 45	242 280 00	7 9	227 520 00
3	FURNISHING, DELIVERING PAINTING, ERECTING REDWOOD PIPE SILLS	288		23 10	6 652 80	7 00	2 016 00	26 00	7 488 00	20 00	5 760 00	22 00	6 336 00	21 50	6 192 00
4.	FURNISHING, DELIVERING, PAINTING, ERECTING OREGON PINE WALKWAYS	58 ±	1000 FT B.M.	119 25	6 976 12 5	40 00	2 340 00	159 00	9 301 50	113 50	6 639 75	113 50	6 639 75	100 00	5 850 00
	TOTAL				263 612 925		252 036 00		288 949 50		253 743 75		255 255 75		239 562 00



SUBMARINE SIPHON PIPE—BAY CROSSING DIVISION—HETCH HETCHY AQUEDUCT.
42-inch flexible joint cast iron pipe for submarine siphons crossing Newark Slough and Dumbarton Strait.

pipe 42 inches in diameter and 2 inches in thickness. The pipe will be in 12 foot laying lengths with flexible joints allowing 10° 45′ maximum deflection at each joint. The pipe will be laid in a dredged trench in the bottom of the Bay or slough, and will be completely covered with mud. The total weight of the pipe will be about 1,700 tons.

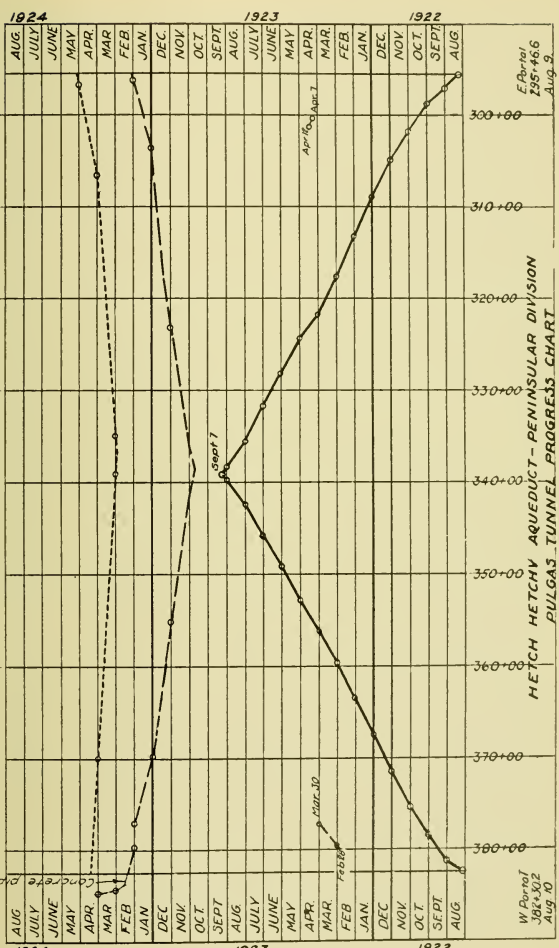
Contract No. 101 for manufacturing the flexible joint pipe was awarded on March 10, 1924, to the United States Cast Iron Pipe and Foundry Company, by the Board of Public Works. To date 27 twelve-foot lengths are completed and awaiting shipment. Over two months were wasted through opposition to this contract award by Acting Mayor McLeran and the Public Utilities Committee before the necessary money was finally appropriated by the Board of Supervisors.

Pulgas Tunnel:

Excavation: Excavation of Pulgas Tunnel was carried on from both portals until the two headings were connected on September 7th, 1923. The formation is Chico sandstone which in general stood well when first excavated but absorbed moisture and became soft on exposure to the atmosphere. Due to the soft nature of the rock, all but 240 feet of of the 8,676 feet of tunnel required timbering.

Lining: The construction of the concrete lining in the tunnel, which had previously been commenced but later suspended during the period of excavation, was resumed immediately after excavation was completed. The sides and arch were first lined, using equipment similar to that used in the Mountain Division tunnels. The water saturated condition of the floor of the tunnel necessitated the installation of a tile sub-drain through nearly the entire length of the tunnel before placing the invert.

Grouting In: In placing the concrete lining in the arch, it was found impracticable to fill the entire excavated space with concrete. The large voids remaining be-


1924
1923
1922
AUG.
JULY
JUNE
MAY
APR.
MAR
FEB
JAN
DEC.
NOV
OCT.
SEPT.
AUG.
JULY
JUNE
MAY
APR.
MAR.
FEB
JAN
DEC.
NOV
OCT.
SEPT.
AUG
Sept 1
Apr 16
Apr 1
Mar 30
Feb 28
W Portal
384+10.2
Aug 10
E Portal
295+46.6
Aug 9
300+00
310+00
320+00
330+00
340+00
350+00
360+00
370+00
380+00
HETCH HETCHY AQUEDUCT - PENINSULAR DIVISION
PULGAS TUNNEL PROGRESS CHART
Excavation.——— Lining sides & arch.— — — Lining invert.-----
Pipe
Concrete

tween the concrete and the rocks were filled, after all concrete had been placed in the sides and arch, by forcing in grout under pressure through holes which had been left open in the concrete for this purpose.

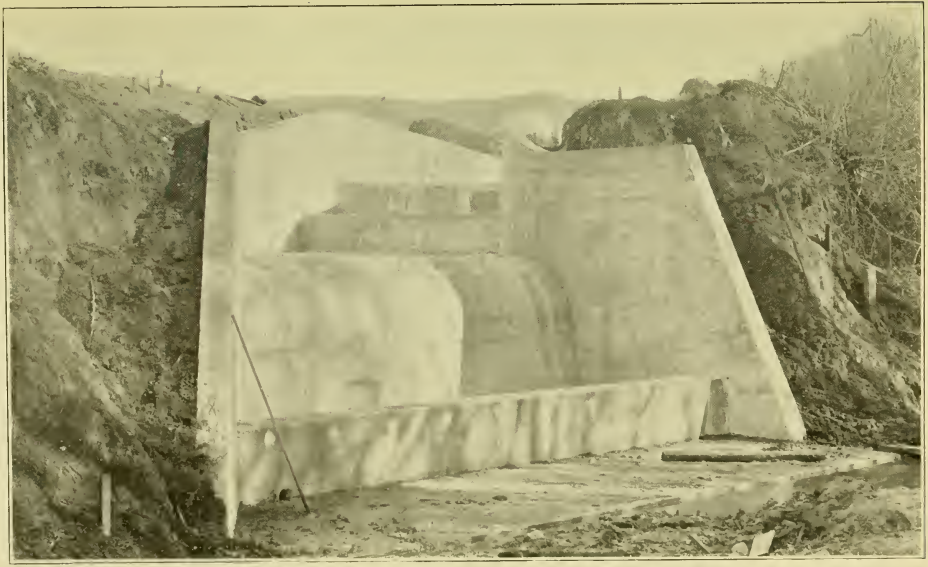
Construction near Portals (Open Cut Work): In the comparatively soft ground near the portals of the tunnel, reinforced concrete pipe of 10-foot 3-inch inside diameter was constructed in place of the standard six-inch concrete lining. On the east side, reinforced concrete pipe of the same inside diameter but of lighter cross section extends 88 feet easterly from the portal and connects with the 5-foot steel pipe. From the west portal, the waterway continues westerly 250 feet as a reinforced concrete pipe 10 feet 3 inches in diameter, then 906 feet as a concrete lined canal, 9 feet wide at the bottom with sides nearly vertical and varying in depth from 12 feet to 3½ feet. The pipe sections in open cut were covered with earth. At the lower end of the canal is a concrete drop structure designed to check the velocity of the water before it flows into Canada de Raymundo Creek.

Pulgas Tunnel, including lining and approaches was completed in May, 1924. The cost under Contract No. 85 was $738,429.23.

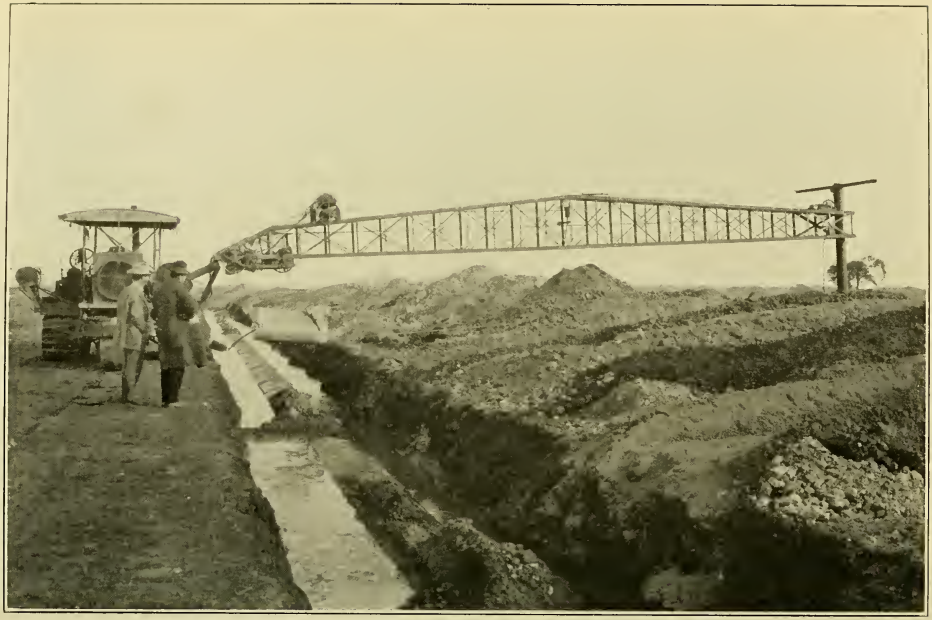
Bay-Pulgas Pumping Plant:

The water from the Spring Valley Water Company's Alameda and Calaveras sources, which will be brought through the City's Bay Crossing pipe line from Irvington to Crystal Springs Reservoir, must be raised 113 feet from the intake at Niles Reservoir to Pulgas Tunnel. This lift will be handled by the Bay-Pulgas pumping plant situated near the Ravenswood pump station of the Water Company, about ½ mile west of Dumbarton Strait.

Under the agreement providing for the use of the pipe line by the Water Company, two pumps of combined capacity of 25 million gallons daily, with motors, necessary



DROP STRUCTURE—HETCH HETCHY AQUEDUCT.
Concrete structure at lower end of outfall canal from Pulgas Tunnel to check velocity of discharging water.



PIPE LINE—BAY CROSSING DIVISION—HETCH HETCHY AQUEDUCT.
Machine used in backfilling pipe line trench.

connections and buildings, were to be furnished by the City. However, at the request of the Company and at its expense, a third pump is to be installed in order to give a total capacity of 32 million gallons daily. Each pump will be direct-connected to a 500-horsepower electric motor. The pumps are being furnished by the De Laval Steam Turbine Company under Contract No. 94 and motors by the General Electric Company under Contract No. 104.

Detailed plans for the plant are in preparation. Construction has not yet commenced.

Aqueduct and Transmission Line Rights of Way

The acquisition of rights of way for the transmission line from Moccasin Creek to Newark, for the aqueduct in the San Joaquin Valley and for the aqueduct from Irvington to the Crystal Springs outfall of the Pulgas Tunnel has been completed except for a few parcels on which it has so far proved impossible to reach satisfactory agreements with the property owners and which are now under condemnation. Rights of way for the aqueduct in the Foothill Division, the Coast Range Division and the portion of the Peninsula Division from Pulgas Tunnel to San Francisco are yet to be acquired.

Pending the settlement of condemnation suits, "writs of possession," or court orders permitting the City to occupy parcels under condemnation, covering all such parcels have been obtained, thus avoiding delay in constructing the transmission line and pipe line.

The rights of way in the San Joaquin and Bay Crossing Divisions lie very largely in highly cultivated agricultural regions and in many cases great difficulty was experienced in convincing property owners that the prices offered by the City were fair. An important factor in holding down the cost was the insertion in deeds of liberal provisions permitting the grantors to retain the use of the right of way lands for agricultural purposes to the

fullest extent consistent with the use of the same lands by the City.

Foothill Division:

The City now owns or has under condemnation right of way easements in the Foothill Division covering 26 miles in length and 350 acres in area for the transmission line from Moccasin Creek to a point about five miles southeast of Oakdale, through Tuolumne and Stanislaus Counties, and also a part of the right of way required for the aqueduct from Moccasin Creek to the west side of the Tuolumne River at Red Mountain Bar in Tuolumne County. The transmission line right of way from Moccasin Creek to the west side of the Tuolumne is 150 feet in width and lies partly through Government land and partly through land in private ownership. The portion through Government land was obtained under the provision of the Raker Act. From the Tuolumne River to the west end of the Division, the transmission line right of way is entirely in privately owned land and is 100 feet in width. This right of way provides space for two lines of towers, 30 feet north and south of the center line.

San Joaquin Division:

From the previously mentioned point 5 miles southeast of Oakdale, in Stanislaus County, to Tesla Portal, in San Joaquin County, the transmission lines and the aqueduct pipe lines will follow the same right of way. A strip of land 35.4 miles in length, containing 533 acres has been purchased in fee for this purpose. The width of this strip is, in general, 110 feet and where this width obtains, the two lines of towers will be placed with their center lines 70 feet apart. For some distance each side of the San Joaquin River the width of right of way is greater, varying up to 150 feet. This increase in width was made in order to accommodate special high towers which will be used for the river crossing and also to permit spreading the pipe

lines to a greater distance apart at the river crossing than is considered necessary elsewhere. The standard towers are 97 feet in height and 18 feet square at the ground line, while the special towers are 208 feet in height and 44 feet square at the ground. Permits to construct the north transmission line across the river have been obtained from the United States War Department and the State Reclamation Board. Permits and easements have been obtained from railroad companies and irrigation districts to cross their properties with the transmission lines and pipe lines.

Coast Range Division:

From Tesla Portal westerly, the transmission lines and the aqueduct follow different routes. A separate route from Tesla Portal westerly had to be selected for the pole line over flatter country further north, away from the steep ridges to be penetrated by the tunnel aqueduct. Right of way in easement has been acquired for the transmission lines from Tesla Portal to a point near the Pacific Gas & Electric Company's Newark sub-station in Alameda County, about three miles southwest of Irvington. This right of way covers a length of 37.3 miles and a width of 100 feet and contains 450.8 acres. The arrangement of the towers will be the same as in the Foothill Division. The construction of the north tower line is under way on this right of way. The acquisition of the right of way for the aqueduct line in this division is not yet commenced; this will be a part of the work of constructing the Coast Range tunnels to be provided for by the proposed new bond issue.

Bay Crossing and Peninsular Divisions:

Rights of way covering a distance of 21.8 miles and comprising 319.3 acres have been acquired (except for a few acres under condemnation) for the pipe line from Irvington to Pulgas Tunnel through Alameda and San Mateo Counties and for the Pulgas Tunnel itself near

Crystal Springs Reservoir. For the greater part of this distance the right of way is 80 feet in width. In Redwood City, where the land values are higher than in the open country, the width is 60 feet. The narrowed width is somewhat less convenient for construction but the slightly greater expense of construction is offset by the lower cost of right of way. Several tracts of land adjacent to the right of way have been purchased for use as pipe yards, a pump station site, camp sites, etc.

Permits to construct the aqueduct across the navigable channels of San Francisco Bay at Dumbarton Strait and Newark Slough have been granted by the United States War Department.

After investigation of a number of possible sites for a tubercular preventorium, the Board of Supervisors and the Board of Health selected a location on a tract of land on the north slope of Cordilleras Canyon, west of Redwood City, close to the Pulgas Tunnel. This tract, containing 301.6 acres, was then owned by the Allis-Chalmers Manufacturing Company but has now been acquired by the City. The survey and the negotiations for the purchase of this land were handled through the Hetch Hetchy Water Supply organization.

CONTRACT NO.	TITLE OF CONTRACT	DIVISION TO WHICH CHARGEABLE	GE	...E ...WED ...YS	DATE OF ACCEPTANCE	FINAL ESTIMATE. CONTRACT ITEMS	FINAL ESTIMATE. EXTRAS & DEDUCTIONS	FINAL ESTIMATE. AMOUNT PAID	EXPIRED TIME FROM CONTRACT TO ACCEPTANCE	REMARKS	CONTRACT NO.
Col. 1.	Col. 2.	Col. 3.		16.	Col. 17.	Col. 18.	Col. 19	Col. 20.	Col 21.	Col. 22.	Col 23.
TOTALS BROUGHT FORWARD FROM SHEET 3. *						$3,395,956.60	+ $2,400.00 - 10,015.11	$3,446,780.65			
61	Construction of the Hetch Hetchy Dam & Appurtenant Works.	H.H.	Dam to ry with above t constr future		June 30, 1923	6,105,307.51	+ 15,499.35 -314,736.69	5,746,066.77	1418	Figures in Cols. 10.11.12. are for dam with siphon spillway contractor furnishing all materials. Figures for overflow spillway were lower	61
62	Furnishing & delivering 18" Air Pipe	Mtn.	7,980 ft made o		July 31, 1918.	5,224.20	- 234.80	4,989.40	53	Minus $234.80 acct. bags substituted for cinch bands	62
63	Furnishing & delivering Refrigerating Machines & Equipment	Mtn.	1-Refr		Oct. 24, 1913.	5,715.00		5,715.00	107	18 days extension.	63
64	Furnishing & delivering Self-Dumping Skips & Side Plates.	Mtn.	4-Self vertical		Sept. 13, 1913.	2,929.00	- 22.75	2,906.25	49	30 days extension granted, acct changes in deliveries made by City Eng. $22.75 deducted for labor performed by City.	64
65	Furnishing & delivering Station Pump for Big Creek Shaft.	Mtn.	1-Moto Turbine	0	Mar. 19, 1920.	2,787.50		2,787.50	218	60 days extension granted acct. labor trouble.	65
66	Furnishing & delivering 41"x 90" Slide Gates for Hetch Hetchy Dam.	H.H.	6-Slid all ope	28, 1921	Feb. 24, 1922	121,000.00	3,724.35	124,724.35	747	Extra $3,724.35 to cover Bonus, Test Pcs. & Freight. $1800 paid to R. Hunt for inspection.	66
67	Furnishing & delivering 35"x 41" Slide Gates for Hetch Hetchy Dam.	H.H.	6- Slid all ope	30, 1921	Jan. 20, 1922.	170,000.00	4,929.82	174,929.82	225	Bids of Mar. 24 & Apr. 21 rejected acct. excessive price. Extra to cover Bonus, Test Pcs. & Freight	67
68	Furnishing & delivering 5 Ft Balanced Valves for Hetch Hetchy Dam.	H.H.	4- Bal with a	1921.	Nov. 2, 1921	173,100.00	4,080.13	177,180.13	353	Extra $4,080.13 to cover Freight $1680. paid to R. Hunt for inspection	68
69	Furnishing & delivering 3 Ft. Balanced Valves for Hetch Hetchy Dam.	H.H.	6- Bal with oi	1921.	Apr. 27, 1921	98,500.00	7,373.18	105,873.18	378	Extra $7,373.18 to cover Freight & Bonus	69
70	Furnishing & delivering Electric Traveling Crane	Moc.	270.00 lift, S	31, 1923	Aug. 5, 1923	30,660.80		30,660.80	209		70
71	Furnishing & delivering Station Pump for Second Garrotte Shaft	Mtn.	1-Moto Turbine		Mar. 19, 1920.	1,702.00		1,702.00	235	Lowest Bid rejected, acct error in estimate, 180 days extension acct labor trouble	71
72	Furnishing & delivering Air Pipe.	Mtn.	3930 ft made o fittings	0	Nov. 11, 1919.	8,102.10		8,102.10	88		72
73	Furnishing & delivering Standard "Wrought Pipe Blk. with couplings & protectors.	Mtn.	5,000 ft 5,000 - 7,000 - 7,000 -		Sept. 17, 1919.	6,678.50		6,678.50	71	12 days extension acct. labor trouble.	73
74	Furnishing & delivering Tie-Plates.	R.R.	12,000 rails o	0	May. 6, 1920.	4,496.63		4,496.63	198	185 days extension acct. labor trouble.	74
75	Placing, tamping & finishing ballast in the track of the Hetch Hetchy Railroad.	R.R.	Track	0	Dec. 17, 1919	3,426.13	- 527.04	2,899.09	63	Contract called for 4 miles. About 7 miles completed. Contractor released from further work. $527.04 deducted for unfinished surfacing & freight charges due City.	75
76	Furnishing & delivering 14" Air Pipe.	Mtn.	5005 ft made o 300 cinc 12 gage	5	Jan. 25, 1922	12431.10	12,353.40	24,784.50	353	Extra $12,431.10 for 4970 ft. of pipe & 300 cinch bands, authorized by Bd. of Wks.	76
77C	Construction of Aqueduct Tunnels in Mtn. Div. on a cost-plus-fee basis.	Mtn.	Concre 10'-3" x sections	00		8,216,299.90 See	note	8,216,299.90 below.		Cost-plus-fee Contract	77C
78	Furnishing & delivering Electric Transmission Line Conductors.		177 m sion l		1924.						78
79A	Furnishing & delivering Water Wheels for Moccasin Creek Power Plant.	Moc.	Four 2 water	31, 1913		236,373.09		236,373.09			79 A
79B	Furnishing & delivering Valves for Moccasin Creek Power Plant.	Moc.	Eight operat Cylinde	23, 1913		26,437.53		26,437.53			79 B
80	Furnishing & delivering Electric Generators and Accessories for Moccasin Creek Power Plant	Moc.	Four 2 Genera Motors Exciter	24, 1923		247,345.30		247,345.30			80
TOTALS						17,674,059.57	+150,361.79 -325,601.99	17,618,799.37			

Includes payments on uncompleted contracts

EXPLANATION OF ABBREVIATIONS IN COL. 3.
H.H. - Hetch Hetchy reservoir and dam.
Mtn. - Mountain division.
R.R. - Hetch Hetchy Railroad.
Moc. - Moccasin Creek Power Plant.

CONTRACTS — HETCH HETCHY WATER SUPPLY

Col 1	Col 2	Col 3	Col 4 GENERAL DESCRIPTION	Col 5 LOCATION OF WORK OR LOCATION FOR WHICH MATERIAL ETC. WAS PURCHASED	Col 6 ENGINEER'S ESTIMATE OF COST	Col 7 AMOUNT OF BOND FOR FAITHFUL PERFORMANCE	Col 8 DATE OF OPENING BIDS	Col 9 NO. OF BIDS	Col 10 HIGHEST BID	Col 11 LOWEST BID	Col 12 SUCCESSFUL BID	Col 13 CONTRACTOR	Col 13A CONTRACTOR'S ADDRESS	Col 14 DATE OF AWARD	Col 15 DATE OF SIGNING CONTRACT	Col 16 TIME ALLOWED IN DAYS	Col 17 DATE OF ACCEPTANCE	FINAL ESTIMATE Col 18 CONTRACT ITEMS	FINAL ESTIMATE Col 19 EXTRAS & DEDUCTIONS	FINAL ESTIMATE Col 20 AMOUNT PAID	Col 21 AMOUNT PAID PER CUBIC YARD OR PER FOOT	Col 22 REMARKS	Col 23 CONTRACT NO
					$ 2404910	$ 415,350			$2,878,351.42	$2,174,814.46	$2,195,011.52							$ 2,345,956.60	+ 83,405.91 - 18,815.32	$ 2,410,547.19			
		M	Dam to be of concrete masonry with a maximum height above foundations of abt 300 ft constructed with a view to [illegible]	H H Reservoir	$ 4,000,000	$ 400,000	July 30, 1919	1	3,475,919.63	3,447,791.50	3,447,791.50	Utah Construction Co	814 Phelan Bldg S F	Aug 1, 1919	Aug 12, 1919	906	June 30, 1923	6,105,507.51	+ 15,479.25 - 314,130.68	5,746,856.77	14.18	Figures in Cols 18 & 19 are for dam with siphon spillway contractor furnishing all materials Figures for over flow spillway were lower	61
		WPC	[illegible] of 8 ft dia riveted pipe [illegible] of 3/8 gage steel & fittings	Aqueduct Tunnels - Mtn Div	5300	1,000	June 6 1919	2	5,281.40	5,214.20	5,214.20	Western Pipe & Steel Co	444 Market St. S.F.	June 11, 1919	June 28 1919	15	July 31 1919.	5,214.20	- 136.80	4,987.40	33	Minus $136.80 acct Tugs substituted for cinch bands	62
		WPC	1 Refrigerating & Cooling Plant	Boarding Houses of permanent camps	6,000	1,500	June 9, 1919	3	10,368.50	5,715.00	5,715.00	Walter S. Leland.	67 Second St S F	June 13, 1919.	July 9 1919	60	Oct. 24, 1919	5,715.00		5,715.00	107	15 days extension	63
		WPC	4 Set - dumping skips for vertical shafts	Big Creek Shaft and Second Garrette Shafts	4,750	1,000	July 2 1919	2	3,912.00	2,912.00	2,913.00	Michel & Pfeffer Iron Works	1415 Harrison St S.F	July 9, 1919	July 18 1919	18	Sept 13, 1919	2,912.00	- 22.75	2,906.75	49	30 days extension granted acct delays in delivery of steel by City Final $22.75 deducted for labor performed by City.	64
		WPC	Motor Driven Centrifugal Turbine Pump 150 gals per min.	Big Creek Shaft	3500	800	July 23 1919	4	3,670.00	2,287.50	2,287.50	Worthington Co. Inc.	Sharon Bldg S.F	July 30 1919	Aug 14, 1919	108	Mar. 19, 1920	2,287.50		2,287.50	218	30 days extension granted acct labor trouble	65
		M	6 Slide Gates complete with all operating mechanism	Hetch Hetchy Dam.	120,000	40,000	Mar 3, 1920	4	170,000.00	121,000.00	121,000.00	Coffin Valve Co.	Monadnock Bldg	Mar. 5, 1920.	May 19, 1920	Feb 19 1921	Feb 24, 1922	121,000.00	3,724.35	124,724.35	747	Extra $3,724.35 for cover Bonus, Test Pits Freight $300 paid to A Hunt for inspection	66
		H H	6 Slide Gates complete with all operating mechanism.	Hetch Hetchy Dam.	130,000	20,000	June 7, 1920	1	170,000.00	170,000.00	170,000.00	Union Machine Co.	934 Brannan St.	June 4, 1920	June 9 1920	June 14 1921	Jan. 20, 1922	170,000.00	4,929.62	174,929.62	225	Bills of Mar 24 & Apr 21 rejected acct extra shop price Extra to cover Bonus, Test Pits & Freight	67
		H H	6 Balanced Valves complete with all operating mechanism	Hetch Hetchy Dam.	155,000	50,000	Mar. 10. 1920	2	189,200.00	173,100.00	173,100.00	Wm Cramp & Sons Ship & Eng. Bldg. Co.	Philadelphia, Penn	Mar. 19 1920	Mar 26, 1920	Feb 28 1921	Nov. 2, 1921	173,100.00	4,080.13	177,180.13	355	Extra $4,080.13 to cover Freight $1680 paid to A Hunt for inspection	68
		H H	6 Balanced Valves complete with all operating mechanism.	Hetch Hetchy Dam.	75,000	25,000	Mar. 31, 1920.	1	98,500.00	98,500.00	98,500.00	Wm. Cramp & Sons Ship & Eng. Bldg Co.	Philadelphia, Penn	Apr. 2, 1920.	Apr 14 1920.	Feb 28 1921	Apr. 27, 1921	98,500.00	7,373.18	105,873.18	378	Extra $7,373.18 to cover Freight & Bonus	69
		Mac	270 000 lb crane, 32 ft lift, 50 ft span.	Moccasin Creek Power House.	30,475	5,000	Dec 6, 1922	6	33,835.00	24,675.00	30,415.00	Dowling & Harnishfeger Co.	32 Beale St, S.F.	Dec 14, 1922	Jan 8, 1923	Mar 31, 1923	Aug 5, 1923	30,660.00		30,660.00	209		70
		WPC	1 Motor Driven Centrifugal Turbine Pump 400 gals. permin	Second Garrette Shaft	1,750	500	July 23, 1919	5	2,295.00	1,595.00	1,702.00	Allis-Chalmers Mfg Co.	Rialto Bldg. S.F.	July 30, 1919	Aug 7, 1919	85	Nov 19 1920	1,702.00		1,702.00	235	Lowest Bid rejected acct error in estimate 140 days extension acct labor trouble	71
		WPC	5930 ft of 24" dia riveted pipe made of 3/8 gage steel and fittings.	Aqueduct Tunnels Mountain Division.	9,000	1,000	Aug 6, 1919	3	9,598.50	8,102.10	8,102.10	Montague Pipe & Steel Co.	Hobart Bldg. S.F.	Aug 11 1919.	Aug 15 1919	110	Nov 11, 1919	8,102.10		8,102.10	88		72
		WPC	5 000 ft - 1" Std. W.I. Pipe. BIK 5 000 - - 1½ - - - - - 7 000 - - 2" - - - - -	Aqueduct Tunnels Mountain Division.	1,500	2,000	Aug. 13, 1919	1	8,128.60	6,678.50	6,678.50	R W Kinney Co	586 Howard St. S.F.	Aug 15, 1919	Sept 10 1919	15	Sept. 11, 1919	6,678.50		6,678.50	17	11 days extension acct labor trouble	73
		R R	22,800 Tie-Plates for 60 lb rails of the "Harriman" type.	Hetch Hetchy Railroad.	5,500	1,000	Oct. 1, 1919.	1	5,758.50	4,612.50	4,612.50	United States Steel Products Co.	Rialto Bldg. S.F.	Oct 8. 1919.	Oct 21, 1919	10	May 6, 1920	4,496.63		4,496.63	198	185 days extension acct labor trouble.	74
		P R	Track Ballast.	H H R.R. between Middle Fork trestle and Big Creek Camp.	6,000	1,000	Oct. 8, 1919	1	6,000.00	6,000.00	6,000.00	W. H. London.	San Francisco.	Oct. 10, 1919.	Oct 14, 1919	90	Dec. 17, 1919	3,421.13	- 527.04	2,894.09	63	Contract called for 4 miles. About 3 miles completed Contractor released from further work $527.04 deducted for unfinished surfacing & freight charges due City	75
		WPC	5805 ft of 24" dia riveted pipe made of 3/8 gage steel, 300 cinch bands made of 3/8 gage steel	Aqueduct Tunnels - Mtn Div.	10,500	1,500	Jan. 28, 1920.	1	12,431.10	12,431.10	12,431.10	Montague Pipe & Steel Co.	Hobart Bldg. S.F.	Jan. 30, 1920	Feb 6, 1920	155	Jan. 29, 1922	12,491.10	12,353.40	24,784.50	353	Extra $12,431.10 for 4970 lt. of pipe & 300 cinch bands, authorized by Bd. of Wks.	76
		WPC	Concrete lined tunnel 10'-3" x 10'-3" horse shoe section 18.3 mi long	Early Intake to Priest Reservoir.	7,654,000	100,000	Apr 21, 1920	2	8,952,380.00	7,802,952.80	7,802,952.80	Construction Co. of North America.	451 Mills Bldg. S.F.	May 3, 1920.	Mar. 2, 1920	1000		8,216,299.90	See note	8,216,299.90	below	Cost plus Fee Contract	77C
			177 miles of transmission line cable	Hetch Hetchy Transmission line.	191,329	40000	Jan 10, 1923	2	454,647.00	191,328.86	191,328.86	Anaconda Copper Mining Co.	Chicago.		Jan 15, 1923		Jan 31, 1923	Jan 1, 1924				78
		Mac	Four 25000 H.P. impulse water wheel units	Moccasin Creek Power Plant.	400,000	100,000	Apr. 12, 1922	2	267,000.00	248,800.00	248,800.00	Pelton Water Wheel Co.	19th & Harrison Sts., S.F.	Apr. 28, 1922	May 5, 1922	Aug. 31, 1923		236,379.09		236,379.09			79A
		Mac	Eight Gate Valves operated by Hydraulic Cylinders.	Moccasin Creek Power Plant.		10,000	Apr. 12, 1922	9	116,260.00	37,580.00	37,580.00	Coffin Valve Co.	Monadnock Bldg. S.F.	Apr. 28, 1922	May 5, 1922	Feb 23, 1923		26,437.53		26,437.53			79B
		Mac	Four 22,000 K.V.A. Generators and one Motor-generator Exciter Set.	Moccasin Creek	400,000	100,000	Apr. 12, 1922	3	304,693.00	260,285.00	260,285.00	General Electric Co.	Rialto Bldg. S.F.	May 1, 1922	May 11, 1922	Aug 31, 1923		247,345.30		247,345.30			80
					$ 15,620,174 Does not include contracts not awarded	$ 1,335,150			$23,223,733.62 Does not include contracts not awarded	$6,006,437.34	$6,832,206.50							11,614,059.57	+ 190,561.75 - 383,601.99 Includes payments on uncompleted contracts	11,618,799.57			

Col 3

For Sheets 1, 2 and 3 of this table covering Contracts 1 to 60, inclusive, see Annual Report for Fiscal Year 1921-1922.

Note on Contract 77-C
Cols 18 and 20 show total actual payments charged against contract to June 30, 1924, including fees, plus charges for lumber, power, transportation and hospital service furnished by City, less credit for boarding house collections

CONTRACTS — HETCH HETCHY WATER SUPPLY

Contract No.	Description of Work	Division of Construction	General Description	Location of Work, or Location for which Material, etc., was Purchased	Engineer's Estimate of Cost	Amount of Bond for Faithful Performance	Date of Opening Bids	No. of Bids	Highest Bid	Lowest Bid	Successful Bid	Contractor	Contractor's Address	Date of Award	Date of Signing Contract	Time Allowed in Days	Date of Acceptance	Final Estimate: Contract Items	Final Estimate: Extras & Deductions	Final Estimate: Amount Paid	Elapsed Time Exceeding Time Allowed, in Days	Remarks	Contract No.
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5.	Col. 6.	Col. 7	Col. 8.	Col. 9	Col. 10.	Col. 11.	Col. 12.	Col. 13.	Col. 13A.	Col. 14.	Col. 15	Col. 16	Col. 17	Col. 18	Col. 19	Col. 20	Col. 21	Col. 22	Col. 23
	[illegible] SEE "NEW SHEET" 4				$5,620,174	$1,335,150.00			$3,223,731.60	$2,606,432.34	$2,532,585.58							$17,814,019.57	$-303,601.99	$17,616,793.57			
81	[illegible] switchboards equipment for Power Plant		11-6667 Kv-a transformers, 6 station service transformers, switchgear, and instruments.	Maccoasin Creek Power Plant.	$ 500,000	$135 000.00	Aug 9, 1922	2	$ 431,622.00	$379,585.00	$379,585.00	Westinghouse Electric and Manufacturing Co.	East Pittsburgh, Pa. 1st Nat'l Bank Bldg., S.F.	Aug. 18, 1922	Sept 13, 1922	.552		207,313.05		207,313.05			81
82	[illegible] delivering [illegible] structural steel [illegible] for the [illegible] Power Plant	Maccoasin	660 000 pounds of structural steel	Maccoasin Creek Power Plant.	60,720	16,000.00	Feb. 21, 1923		64,140.00	60,720.00	60,720.00	Union Construction and Drydock Co.	Key Route Basin Oakland, Cal.	Feb. 23, 1923	Mar 10, 1923	127	Jan. 28, 1924	61,408.85		61,408.85	324		82
83	[illegible] & delivering [illegible] cars, mountain equipment, Mountain Division	Mountain	Ten steel single side dump cars for muck hauling	Mountain Division tunnels.	3640	500.00	Mar. 23, 1921	7	3,810.00	3,490.00	3,490.00	Joshua Hendy Iron Works.	75 Fremont St.	Apr 6, 1921	Apr 9, 1921	76	June 24, 1921	$ 3,490.00	+ $150.00	$ 3640.00	76		83
84	[illegible] & delivering [illegible] pipe for [illegible] water tunnel [illegible] of the [illegible]	Mountain	10374 ft of 24" steel pipe, and 550 cinch bands for same.	Mountain Division tunnels.	35,984	8500.00	Feb. 2, 1921	2	13,258.32	10,726.06	10,726.06	Western Pipe and Steel Co. of California.	444 Market St S.F.	Feb. 7, 1921	Mar. 16, 1921	120	Jun. 22, 1922	16,726.06	13,257.61	33,983.67	463		84
85	[illegible] of the [illegible] gas Tunnel	Peninsular	Concrete lined tunnel 16 miles long and 10'-3" in height and width.	Through Pulgas Ridge in San Mateo County near Redwood City.	760,000	137,000.00	June 8, 1922	4	779,310.00	683,050.00	683,050.00	Grant Smith and Co.	708 Balboa Bldg. S.F.	June 23, 1922	July 5, 1922	500		650,690.40		650,690.40			85
86	Furnishing, delivering & erecting a plate girder railroad bridge at Sixbit Gulch on the [illegible] Hetchy Railroad	H.H.R.R.	Single track plate girder railroad bridge of 3 spans.	Sixbit Gulch [Don Pedro Reservoir]	32,500	7,250.00	July 26, 1922	5	37,247.50	26,132.00	26,132.00	Union Construction and Drydock Co.	Key Route Basin Oakland, Cal.	July 28, 1922	Aug 12, 1922	150	Apr 10, 1923	24,630.43		24,630.43	241	Work of contracts 86, 87 and 88 made necessary by raising level of Don Pedro Reservoir	86
87	[illegible] concrete abutments and piers for the Sixbit [illegible]ulch Bridge on the [illegible] Hetchy RR.	H.H.R.R.	2 concrete abutments and 8 concrete piers.	Sixbit Gulch [Don Pedro Reservoir]	28,300	8,750.00	July 26, 1922	3	44,880.00	32,940.00	32,940.00	Schultz Construction Co.	Geary & Polk Sts. S.F.	July 28, 1922	Aug 12, 1922	106	Oct 30, 1922	36,374.39	+ 209.17	36,583.56	79	All but $6300 of the cost of this work is to be paid by Turlock and Modesto Irrigation districts.	87
88	[illegible] roadway for the relocation of the H.H.R.R. at Sixbit Gulch	H.H.R.R.	Grading about 1200 ft. of single track roadbed.	Sixbit Gulch [Don Pedro Reservoir]	10,000	2,100.00	July 26, 1922	6	19,660.00	7,900.00	7,900.00	M. J. Lyons.	512-514 Mission St., S.F.	July 28, 1922	July 31, 1922	60	Mar 16, 1923	2597.89		2597.89	226		88
89	[illegible] & delivering steel reinforced aluminum cable for the [illegible] Creek Power Plant	Transmission line	530 miles of 397000 c.m. cable.	Transmission line from Maccoasin Creek P.H. to Irvington.	374,212	95,000.00	Jan 24, 1923	1	374,211.80	374,211.80	374,211.80	Aluminum Company of America	Pittsburgh, Pa.	Jan 26, 1923	Feb 5, 1923	331		374,203.84		374,203.84			89
90	Constructing Bay Crossing Pipe Line, [illegible] Aqueduct	Bay Crossing	5 foot riveted steel pipe line, 19½ miles long, 3/16" to 7/16" plate.	Irvington, Alameda Co. to Pulgas Tunnel.	2,700,000	446,332.25	May 16, 1923	3	3,326,305.00	2,231,661.25	2,231,661.25	Western Pipe and Steel Co. of California	444 Market St S.F.	May 18, 1923	June 2, 1923	620		1,595,371.05		1,595,371.05			90
91	Furnishing & delivering steel penstocks and accessories for the Maccoasin [illegible] Power Plant	Maccoasin	Penstocks one mile long for 8-12500 H.P. water wheels.	Maccoasin Creek Power Plant.	I- 213,017 II-1,016,525	42,604.00 203,305.00	May 23, 1923	3	I 214,341.25 II-1016,525.00	213,016.70 1,016,525.00	213,016.70 1,016,525.00	I -Western Pipe & Steel Co. II-H.W. Kellogg Co.	444 Market St, S.F. 90 West St, N.Y.	May 28, 1923	I-June 2, 1923	I-220 II-220		175,400.59 962,358.41		175,400.59 962,358.41		I = Upper portion. II = Lower portion.	91
92	Furnishing delivering and driving of test piles across San Francisco Bay at Dumbarton Straits	Bay Crossing	Driving test piles at locations of piers for Dumbarton pipe bridge	Dumbarton Straits		1000.00	May 9, 1923	5	8,939.00	3,811.00	3,811.00	Healy Tibbitts Construction Co.	64 Pine St S.F.	May 14, 1923	June 5, 1923	60	June 13, 1923	3,277.20		3,277.20	14		92
93	Furnishing delivering & erecting steel bridge superstructure for pipe line at Dumbarton	Bay Crossing	36-105 ft spans to carry two 6 ft. 4 in. steel pipes.	Dumbarton Straits		55,000.00	Aug 15, 1923	6	324,809.50	272,162.00	272,162.00	U S Steel Products Co.	Rialto Bldg., S.F.	Aug. 17, 1923	Sept 17, 1923	275		223,451.91		223,451.91			93
94	Furnishing delivering and installing centrifugal pumps.	Bay Crossing	Two pumps, combined capacity 25 million gallons daily.	Bay-Pulgas pumping plant.		7,750.00	Mar. 18, 1924	9	11,500.00	5,125.00	5,125.00	De Laval Steam Turbine Co.	61 Beale St., S.F.	Mar 31, 1924	Apr 22, 1924	150							94
95	Constructing sub-structures for steel bridge across Dumbarton Strait	Bay Crossing	36 concrete piers and 1 concrete caisson to support bridge furnished under Cont. 93.	Dumbarton Strait.		240,000.00	Oct. 17, 1923	2	1,248,175.00	1,192,483.50	1,192,483.50	Healy Tibbitts Construction Co.	64 Pine St., S.F.	Oct. 19, 1923	Nov 8, 1923	April 1, 1924		146,365.92		146,365.92			95
96	Construction of timber trestles for Bay Crossing Pipe Line.	Bay Crossing	19,300 ft of 2-pile bent trestle and 4 concrete anchors.	Over marshes between Newark and Bay-Pulgas pumping plant.		36,000.00	Apr. 30, 1924	6	194,430.00	167,643.00	167,643.00	Leonard F. Vaudall	Matson Bldg., S.F.	Apr. 30, 1924	May 15, 1924	200							96
TOTALS					$21,355,272	$4,764,841.25			$27,376,108.19	$23,493,560.65	$23,343,770.88							$27,418,499.55 Includes unc	$-143,928.57 -303,601.99 payments on completed	$27,202,876.13 on contracts			

EXPLANATION OF ABBREVIATIONS IN COL.

CONTRACTS — HETCH HETCHY WATER SUPPLY

CONTRACT NO.	TITLE OF CONTRACT	DIVISION TO BE CHARGEABLE	GENERAL DESCRIPTION	LOCATION OF WORK, OR LOCATION FOR WHICH MATERIAL ETC. WAS PURCHASED	ENGINEER'S ESTIMATE OF COST	AMOUNT OF BOND FOR FAITHFUL PERFORMANCE	DATE OF OPENING BIDS	NO. OF BIDS	HIGHEST BID	LOWEST BID	SUCCESSFUL BID	CONTRACTOR	CONTRACTOR'S ADDRESS	DATE OF AWARD	DATE OF SIGNING CONTRACT	TIME ALLOWED IN DAYS	DATE OF ACCEPTANCE	FINAL ESTIMATE: CONTRACT ITEMS	FINAL ESTIMATE: EXTRAS & DEDUCTIONS	FINAL ESTIMATE: AMOUNT PAID	CLOSED TIME FROM TIME ALLOWED IN DAYS	REMARKS	CONTRACT NO.
Col. 1	Col. 2	Col. 3	Col. 4.	Col. 5.	Col. 6.	Col. 7.	Col. 8.	Col. 9	Col. 10.	Col. 11.	Col. 12.	Col. 13.	Col. 13A	Col. 14	Col. 15.	Col. 16	Col. 17	Col. 18	Col. 19	Col. 20	Col. 21	Col. 22	Col. 23
	AMOUNTS BROUGHT FORWARD FROM SHEET 7					$2,766,241.25			$73,376,106.15	$73,183,681.65	$73,913,770.63							$22,438,499.55	$(185,318.37 deductions)	$22,202,875.13			
96	Furnishing & delivering permanently valves for Moccasin Power Plant	Moc	Three 104" valves with operating mechanisms & electric motors	Head of Moccasin Creek Penstocks.		10,000.00	Jan. 2, 1924	6	53,900.00	26,728.00	26,728.00	Joshua Hendy Iron Works	75 Fremont St S F	Jan 28, 1924	Feb 3, 1924	135		15,428.25		15,428.25			97
98	Furnishing & delivering electric transmission line insulators	Transm. Line	26000 standard units and 11,500 heavy duty units for 154 Kv	Transmission line, Moccasin P.H. to Newark.		50,000.00	Dec. 9, 1923	5	120,710.00	89,407.50	89,407.50	Westinghouse Electric & Manufacturing Co	1st Nat'l Bank Bldg., S F	Dec 21, 1923	Jan. 4, 1924	To July 15 1924		12,532.18		12,532.18			98
99	Furnishing & delivering electric transmission line towers	Transm Line	About 510 double circuit towers	Do.		125,000.00	Jan. 9, 1924	2	392,878.00	274,224.00	274,224.00	Pacific Coast Steel Co.	Rialto Bldg., S F	Jan. 11, 1924	Jan 23, 1924	To July 1, 1924							99
100	Furnishing & delivering gate valves for Bay Crossing Division	Bay Crossing	2-42", 1-36" and 4-20" gate valves	Bay Crossing Pipe Line and Bay-Pulgas Pump Station		9,167.50	Feb 20, 1924	2	21,282.00	18,335.00	18,335.00	Union Machine Co.	934 Brannan St S F	Mar. 5, 1924	Mar 18, 1924	120							100
101	Furnishing & delivering flexible joint cast iron pipe	Bay Crossing	1618 tons flexible joint C I pipe for submarine siphons	Dumbarton Strait and Newark Slough		59,500.00	Feb 20, 1924	3	272,824.25	196,802.00	196,802.00	U.S. Cast Iron Pipe and Foundry Co.	Burlington, N.J.	Mar 10, 1924	Mar 20, 1924	To Sept 10 1924							101
102	Furnishing & delivering insulating bus supports for Moccasin Power Plant	Moc.	Post insulators for outdoor switching station	Moccasin Power Plant		4,400.00	Mar 19, 1924	9	* 24,952.05	* 15,435.56	* 15,674.10	Ohio Brass Co. Delta-Star Electric Co.	Hobart Bldg. S F 123-2nd St, S F.	Mar 26, 1924	Apr. 9, 1924 Apr 10, 1924	To Sept 1 1924						* Sum of bids on 6 items	102
103	Furnishing & delivering electric transmission line hardware	Transm. line	Hooks and clamps for insulators and coble	Transmission line M.C.P.H. to Newark		2,900.00	Apr. 2, 1924	5	* 12,916.81	* 12,410.11	* 12,469.61	Westinghouse El & Mfg Co Western Electric Co.	1st Nat Bank Bldg. S F 680 Folsom St. S F	Apr 11, 1924	Apr. 24, 1924 Apr 29, 1924	To Aug. 1 1924						* Sum of bids on 6 items	103
104	Furnishing & delivering electric motors for Bay-Pulgas Pumping Plant	Bay Crossing	Two 500 H.P. induction motors and starting apparatus.	Bay-Pulgas Pump Station		1,500.00	Apr 30, 1924	3	7,754.00	6,790.00	6,790.00	General Electric Co.	Rialto Bldg	May 7, 1924	May 22, 1924	130							104
105	Construction of submarine pipe lines	Bay Crossing	Laying pipe furnished under Contract 101.	Dumbarton Strait and Newark Slough																			105
TOTALS						$3,028,708.75			$73,283,323.26	$73,053,040.82	$74,042,204.10							$22,466,459.98	$-185,318.37 -383,601.23	$22,280,856.38			

EXPLANATION OF ABBREVIATIONS IN COL.

Expenditures on Hetch Hetchy Project for Fiscal Year Ended June 30, 1924

Water Construction

Acct. No.	Primary Accounts	Amount
	General Expenditures	
2002	Land, water rights and rights of way	$ 106,637.01
2003	Rental, U. S. Government	15,000.00
2004	Legal expenses	10,749.78
2005	Hydrography	2,890.39
2006	City office administration	40,048.45
2007	City office engineering	85,957.47
2008	State compensation insurance fund	9,004.70
2009	Taxes	7,016.60
2010	Miscellaneous construction expenditures	4,192.42
2012	Unamortized discount on securities	2,017.41
2101	Groveland office administration	50,461.46
2102	Groveland hospital—buildings and equipment	28.21
2104	Groveland hospital—operating expenses	39,074.91
2110	Groveland dwellings	7,335.11
2111	Groveland warehouse	*3,837.51*
2112	Groveland permanent water supply	18,474.28
2113	Groveland rigging equipment	66.48
2124	Groveland stable and garage equipment	5,298.02
	Total	$ 400,415.19
	Hetch Hetchy Division	
2202	Engineering	$ 1,128.89
2203	Camps	*2,089.16*
2204	Roads, trails and tramways	649.74
2205	Dam and appurtenances	34,499.47
2205	Dam and appurtenances—Utah Construction Company (Contract No. 61)	673,014.96
2206	Clearing reservoir	*34,251.30*
2208-D	Dam and appurtenances—3 ft. balanced valves (Contract No. 69)	*29.25*
2226	Telephone lines	243.57
2227	Camp maintenance	15.97
	Total	$ 673,182.89
	Mountain Division—Tunnel Construction	
2402	Engineering	$ 48,764.43
2403	Camps	1,095.87
2404	Roads, trails and tramways	975.58
2405	Adits	306.57
2406	Shafts	1,145.47
2407	Construction—City's forces	48,594.74
2407	Construction—Construction Company of North American (Contract No. 77C)	1,408,869.83
2409	South Fork Crossing, excavation	6,625.75
2426	Telephone lines	17.38
2427	Camp maintenance	298.98
	Total	$ 1,516,694.60

Italics indicate credit.

Expenditures on Hetch Hetchy Project

Water Construction (Cont.)

Acct. No.	Primary Accounts	Amount
	Foothill Division	
2708	Tuolumne River Crossing, total	$ 757.64
	Early Intake Diversion Works	
2902	Engineering	$ 7,221.71
2903	Camps	13,829.32
2904	Roads, trails and tramways	5,613.45
2905	Dam and appurtenances	196,180.00
2906	Spillway	98,269.21
2907	Tunnel construction	176,376.80
2908	Canal construction	1.20
2926	Telephone lines	9.75
2927	Camp maintenance	3,588.08
	Total	$ 499,089.52
	Mather Sawmill	
3004	Roads, trails and tramways	$ 35.97
3027	Camp maintenance	1,398.48
3070	Operating expenses	46,416.28
	Total	$ 47,850.73
	Munn Sand Pit	
3101	Plant and equipment	$ 1,475.58
3170	Operating expenses	15,701.15
	Total	$ 17,176.73
	San Joaquin Division	
3305	Lands and rights of way, total	$ 155,057.36
	Golden Rock Ditch	
3501	Operating expenses, total	$ 7.35
	Boarding and Commissary Expenses	
4000	Boarding houses (City's forces)	$ 341,928.75
4500	Commissary—supplies	*18,409.20*
4510	Commissary—expenses	*5,455.86*
	Total	$ 318,063.69
5000	Material and Supplies — Expenditures $1,113,600.28	
5010	M. and S. Misc. Construction Expenditures — Disbursements 1,235,985.42	$ *122,385.14*

Italics indicate credit.

Expenditures on Hetch Hetchy Project

Water Construction (Cont.)

Acct. No.	Primary Accounts	Amount
	Bay Development	
6001	General engineering	$ 8,378.90
6002	Lands and rights of way	92,883.80
6007	City office administration and engineering	19,575.45
6102	Newark Division—Engineering	3,157.09
6107	Newark Division—Trestle for pipe line (Contract No. 96)	15,708.57
6201	Ravenswood Division—Surveys and investigations	10.94
6202	Ravenswood Division—Engineering	3,038.59
6207	Ravenswood Division—Substructures and superstructures across Dumbarton Straits (Contracts Nos. 93, 95)	468,025.84
6302	Redwood Division—Engineering	7,559.57
6307	Redwood Division—Pipe line (Contract No. 90)	1,685,955.37
6402	Peninsular Division—Engineering	16,083.29
6407	Peninsular Division—Tunnel construction (Contract No. 85)	335,724.32
	Total	$ 2,656,101.73
	Total Gross Expenditures Water Construction	$ 6,162,012.29

Under the terms of Contract No. 77C (Acct. No. 2407) the Contractor is charged for all material, power and transportation service furnished by the City. These charges are included as expenditures as herein set forth against the Contract and deducted as listed below, as such charges are not covered directly by actual cash expenditures:

Difference in Hospital dues	$ *7,706.67*	
Lumber furnished	*2,449.70*	
Power furnished	*71,450.85*	
Transportation of employees	*2,298.03*	
Transportation of materials and supplies	*79,874.84*	*$153,780.09*
Total Net Expenditures—Water Construction		$ 6,008,232.20

Italics indicate credit.

Expenditures on Hetch Hetchy Project

Power Construction

Acct. No.	Primary Acounts	Amount
2008	State compensation insurance (undistributed), Total	$ 3,065.63
	Lake Eleanor Division	
2302	Engineering	$ 48.40
2303	Camps	2.13
2304	Roads, trails and tramways	3,110.29
2305	Dam and appurtenances	697.07
2306	Clearing reservoir	1,372.79
2326	Telephone lines	253.13
	Total	$ 5,483.81
	Priest Divison	
2502	Engineering	$ 4,807.59
2503	Camps	58.17
2504	Roads, trails and tramways	598.99
2505	Dam and appurtenances	66,772.47
2506	Reservoir	971.54
2507	Outlet or power tunnel	289,427.11
2508	Diversion tunnel	4,795.51
2526	Telephone lines	26.47
2527	Camp maintenance	1,356.92
	Total	$ 368,814.77
	Moccasin Creek Division	
2602	Engineering	$ 29,357.06
2603	Camps	123,611.56
2604	Roads, trails and tramways	20,529.34
2606	Penstock (Contracts Nos. 91A and 91G)	1,552,614.30
2607	Power plant—Buildings and structures (Contract No. 85)	400,108.93
2608	Power plant—Hydraulic equipment (Contracts Nos. 79 and 79A)	144,976.61
2609	Power plant—Electrical equipment (Contracts Nos. 80 and 81)	198,332.11
2613	Power plant—Miscellaneous equipment (Contract No. 70)	30,531.29
2626	Telephone lines	73.79
2627	Camp maintenance	10,518.06
2628	General equipment	44,213.36
2691	Concrete store plant	27,592.56
2692	Stable and garage expense	12,413.12
2693	Locomotive crane expense	19,205.56
2695	Machine shop expense	21,753.64
2696	Carpenter shop expense	801.57
2697	Blacksmith shop expense	4,469.25
2698	Materials and supplies	*121,308.73*
2699	Materials and supplies—Expense	*12,682.23*
	Total	$ 2,507,111.15

Italics indicate credit.

Expenditures on Hetch Hetchy Project

Power Construction (Cont.)

Acct. No.	Primary Accounts	Amount
	Lower Cherry Power Development	
2804	Roads, trails and tramways	$ 20.04
2814	Transmission line—Poles and fixtures	83.51
2817	Transmission line—Substation and general buildings	336.21
2818	Transmission line—Substation equipment	58.95
2820	Transmission line—Transformers and devices	81.18
2870	Operating expenses	69,033.55
	Total	$ 69,613.44
	Power Transmission System	
3201	Surveys and investigations	$ 1,485.72
3202	Engineering	26,210.92
3203	Camps	34,169.88
3204	Roads, trails and tramways	12,018.33
3205	Land and rights of way	91,368.54
3209	Materials and supplies	*1,174.42*
3213	Miscellaneous electrical production equipment	43,284.67
3214	Poles and fixtures (Contracts Nos. 89 and 98)	89,649.89
3215	Overhead system	394,775.95
3216	Clearing transmission line	6,207.65
	Total	$ 697,997.13
	Total Net Expenditures—Power Construction	$ 3,652,085.93

Hetch Hetchy Railroad

Investment Accounts—Additions and Betterments	$ *817.65*	
Investment Account—Materials and Supplies	*1,523.49*	$ *2,340.14*
Operating Expenses		339,804.34
Total Expenditures—Railroad		$ 337,464.20

Miscellaneous Credits

During the fiscal year the following amounts have been deposited with the City Treasurer to the General Hetch Hetchy 1910 Bond Fund, and credited herein to the various appropriate accounts, reducing the expenditures:

Materials and Supplies—Water	$ 63,573.20
Materials and Supplies—Power	14,820.93
Materials and Supplies—Railroad	3,891.61
Sale of Work Locomotives (2)—Railroad	4,000.00
State Compensation Insurance Fund	52,559.73
Total amount credited to the above accounts	$138,845.47

Italics indicate credit.

Receipts from Operations (Not Included in the Foregoing) —Deposited to the General Hetch Hetchy Bond Fund

Acct. No.		Amount
	Water Construction	
2002	Crocker Amazon Tract Rentals	$ 2,546.70
2002	Mather. Yosemite National Park Co. Rentals	50.00
2103	Groveland Hospital Receipts	25,759.02
2109	Groveland Dwellings Receipts	1,915.00
3040	Mather Sawmill Receipts	35,163.21
4000	Boarding Houses—City forces Receipts	284,736.69
4000	Boarding Houses—Contractor's forces Receipts—Contract No. 77C	146,142.16
	Total Receipts—Water Construction	$ 496,312.78
	Power Construction	
	Sale of power—Total receipts	$ 66,152.87
	Railroad Operation	
	Freight revenue	$ 331,559.85
	Passenger revenue	28,539.15
	Mail revenue	3,865.43
	Rent from work equipment	1,405.00
	Miscellaneous receipts	1,404.28
	Receipts—Railroad operations	$ 366,773.71
	Turlock, Modesto Irrigation Districts—Donations	80,771.41
	Total Receipts—Railroad	447,555.12

Summary of Expenditures and Receipts
Hetch Hetchy Project

Expenditures

Water Construction	$6,008,232.20	
Power Construction	3,652,085.93	
Railroad Construction and Operation	337,464.20	$ 9,997,782.33

Receipts

Water Construction	$ 496,312.78	
Power Construction	66,152.87	
Railroad Construction and Operation	447,555.12	$ 1,010,020.77
Total Net Expenditures for year 1923-1924		$ 8,987,761.56
Total Net Expenditures prior to July, 1923	$27,647,343.69	
Less Materials and Supplies, 1919 Account	*99,874.16*	$27,547,469.53
Total Net Expenditures to June 30, 1924		$36,535,231.09

Addenda

Interest Received on Bay Development Expenditures

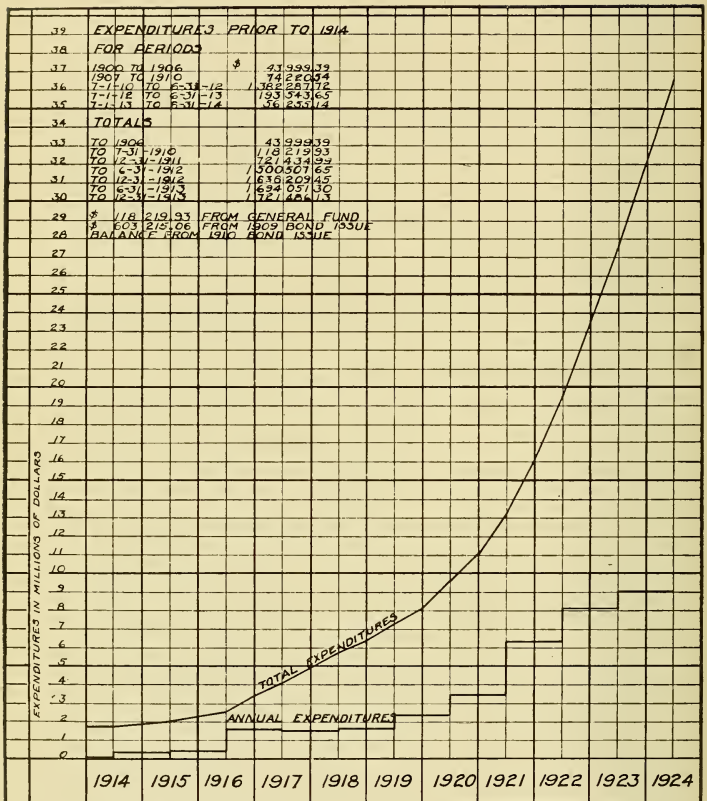
(July 1, 1923-June 30, 1924)

Credited to Bond Interest Fund	$ 51,604.25

Non-Revenue Services or Earnings

Credited to the Railroad in report to the Railroad Commission for year ended December 31, 1923, in addition to the foregoing receipts:		
Water and Power Services	$263,585.51	
Railroad Services	1,315.68	$ 264,901.19

Italics indicate credit.



HETCH HETCHY WATER SUPPLY OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

GRAPHIC RECORDS OF

ANNUAL AND TOTAL EXPENDITURES

DEPARTMENT OF PUBLIC WORKS. APPROVED M.M. O'Shaughnessy CITY ENGINEER

BY H.O.S. . . . TRACED H.O.S. . . . CHECKED . . . . . .

SCALE . . . . . DATE JUNE 30, 1924.

A 166

Hetch Hetchy 1910 Bond Fund

Statement as at June 30, 1924

Treasurer's balance June 30, 1924	$5,867,518.25	
Misc. collections for June	6,040.07	
Receipts from Boarding Houses and Hospital	32,054.45	$5,905,612.77
Less Audited Vouchers and Payrolls June, 1924	567,524.86	
Contract Liabilities	3,041,270.28	3,608,795.14
Balance available		2,296,817.63
Operative Revenue Fund June 30, 1924	1,251,235.74	
Receipts for June not included above	4,919.04	1,256,154.78
Total Balance		3,552,971.41

Contract Liabilities

Cont. No.	Contractor	Amount Of Contract	Paid	Due
77C	Construction Co. of No. America	$7,802,592.80	$8,216,299.90	
78C	Anaconda Copper Mining Co.	195,000.00		$ 195,000.00
79	Coffin Valve Co.	37,580.00	26,447.53	11,132.47
79A	Pelton Water Wheel Co.	248,800.00	236,379.09	12,420.91
80	General Electric Co.	260,285.00	247,345.98	12,939.02
81	Westinghouse Electric & Mfg. Co.	379,585.00	287,913.45	91,671.55
85	Grant Smith Co.	700,000.00	650,710.40	49,289.60
89	Aluminum Co. of America	389,200.00	374,203.84	14,996.16
90	Western Pipe & Steel Co.	2,300,000.00	1,595,571.05	704,428.95
91A	Western Pipe & Steel Co.	220,000.00	175,400.58	44,599.42
94	De Laval Steam Turbine Co.	5,125.00		5,125.00
93	U. S. Steel Products Co.	300,000.00	222,451.09	77,548.91
95	Healy-Tibbitts Construction Co.	1,250,000.00	244,267.26	1,005,732.74
96	L. F. Youdall	167,645.00		167,645.00
97	J. Hendy Iron Works	27,473.00	15,428.25	12,044.75
98	Westinghouse Electric & Mfg. Co.	141,000.00		141,000.00
99	Pacific Coast Steel Co.	450,000.00		450,000.00
100	Union Machine Co.	18,335.00		18,335.00
102	Delta Star Electric Co.	2,736.00		2,736.00
102	Ohio Brass Co.	12,937.00		12,937.00
103	Western Electric Co.	4,897.80		4,897.80
104	General Electric Co.	6,790.00		6,790.00
	Balance due on Contracts June 30, 1924			$3,041,270.28

CONTENTS

	Page
LETTER OF TRANSMITTAL	5
INTRODUCTION	7
PROJECTS AND INVESTIGATIONS:—	
Sunset Tunnel	8
Rincon Hill Regrade	12
Van Ness Avenue Extension	13
Islais Creek Reclamation District	13
Ingleside Heights	14
Capp Street Widening	14
Bernal Cut	15
Park Panhandle Extension	15
Sunset Boulevard	16
Diagonal Boulevard and Parkways	16
Miscellaneous Activities	16
BOULEVARDS, STREETS AND HIGHWAYS	19
SEWERS	33
MISCELLANEOUS CONSTRUCTION:—	
Street Signs	36
Bridge Cleaning, Painting and Repairs	36
High Pressure System Extensions	36
Municipal Water Supply System Extension	37
MUNICIPAL RAILWAY:—	
Market Street Railway Purchase	38
Extensions	39
Equipment	40
Carbarns and Shops	40
Power Rates and Facilities	41
SURVEYS	43
STREET IMPROVEMENT ASSESSMENTS, ETC.	45
HETCH HETCHY WATER SUPPLY:—	
Progress and Developments	47
Organization and Headquarters Work	48

CONTENTS—Continued

HETCH HETCHY WATER SUPPLY—Continued:— Page
Hetch Hetchy Railroad 52
O'Shaughnessy Dam 54
Lake Eleanor 55
Mather Sawmill 55
Mather Vacation Camp 56
Mountain Division Aqueduct Tunnels 56
Early Intake Diversion Works 63
Moccasin Power Development 66
Lower Cherry River Power System 76
Bay Development 77
Aqueduct and Transmission Line Rights of Way 93

ILLUSTRATIONS AND DIAGRAMS

Page

DEDICATION OF O'SHAUGHNESSY DAM ..... Frontispiece

CONTEMPLATED PROJECTS MAP ..... opposite 7

WARREN HARDING MEMORIAL BOULEVARD 17

MARINA BOULEVARD 18

LIBERTY AND SANCHEZ STREETS:—
Showing retaining walls, double roadway, etc. 20
Showing re-alignment of streets 21

COLLINGWOOD STREET—Section of special treatment street improvement 23

CAINE AVENUE FROM LAKEVIEW NORTHERLY—A special treatment street improvement 24

SLOAT BOULEVARD, GREAT HIGHWAY AND SKYLINE BOULEVARD INTERSECTION 26

BUCHANAN STREET, DUBOCE AVENUE TO HERMANN STREET 28

CORTLAND AVENUE FROM SAN BRUNO AVENUE WESTERLY 30

MOCCASIN POWER PLANT—General View 46

COSTS OF LABOR AND MATERIALS AND NUMBER OF MEN EMPLOYED, HETCH HETCHY WATER SUPPLY (Graphic Record) 50

AQUEDUCT TUNNELS MOUNTAIN DIVISION, H. H. W. S., PROGRESS CHART ..... opposite 56

EARLY INTAKE DIVERSION DAM, H. H. W. S.:—
Showing downstream face of dam and spillway 64
Showing upstream face of dam and aqueduct tunnel portal 65

PENSTOCK PIPE AND Y, MOCCASIN POWER PLANT, H. H. W. S. 67

SURGE CHAMBER, MOCCASIN POWER DEVELOPMENT, H. H. W. S. 69

ILLUSTRATIONS AND DIAGRAMS—(Continued)

Page

MOCCASIN POWER HOUSE, H. H. W. S.:—
Exterior view 71
Interior view 73

PIPE LINE, BAY CROSSING DIVISION, HETCH HETCHY AQUEDUCT:—
60-inch Steel Pipe in Trench 78
60-inch Steel Pipe on Steel Bents 79

DUMBARTON BRIDGE, BAY CROSSING DIVISION, HETCH HETCHY AQUEDUCT:—
Steel cylinders used in construction of cofferdam 83
Standard piers and spans 84

SUBMARINE SIPHON PIPE, BAY CROSSING DIVISION, HETCH HETCHY AQUEDUCT 87

PULGAS TUNNEL, PENINSULAR DIVISION, HETCH HETCHY AQUEDUCT, PROGRESS CHART 89

PIPE LINE, BAY CROSSING DIVISION, HETCH HETCHY AQUEDUCT—Machine used in backfilling trench 92

ANNUAL AND TOTAL EXPENDITURES, HETCH HETCHY WATER SUPPLY—Graphic Record 104

TABLES

Page

SUNSET TUNNEL (EUREKA VALLEY ROUTES)—Comparative Data 10

MISSION-SUNSET TUNNEL—Statistics of Tunnel and Assessment District 12

STREET WORK PERFORMED UNDER CONTRACTS 31

DEPOSITS RECEIVED FOR SIDE SEWERS 34

CURRENT CONTRACT DATA—Boulevards, Sewers, Municipal Railways, Miscellaneous ..... opposite 42

SURVEYS PERFORMED 43

PRECISE LEVELS AND BENCH MARKS 43

MAPS APPROVED AND FILED 43

FEES RECEIVD FOR SURVEYS AND INSPECTION 44

ASSESSMENTS AND BONDS FOR STREET WORK 45

STREET WORK PROCEEDINGS 45

NOTICES, PERMITS AND INVESTIGATIONS 45

PERMITS AND FEES FOR CORPORATION TRENCHES 45

AQUEDUCT TUNNELS, MOUNTAIN DIVISION, H. H. W. S.—Excavation Progress 58

PRIEST DAM—Construction Quantities 66

LOWER CHERRY RIVER POWER SYSTEM, H. H. W. S.—Statistics of Operation 77

DUMBARTON BRIDGE, BAY CROSSING DIVISION, HETCH HETCHY AQUEDUCT:—

Contract No. 95, Substructures—Record of bids received 81

Contract No. 93, Superstructures—Record of bids received 86

CONTRACT DATA, H. H. W. S. ..... opposite 96

EXPENDITURES ON HETCH HETCHY PROJECT—For the fiscal year ended June 30, 1924 97

HETCH HETCHY 1910 BOND FUND—Statement as at June 30, 1924 105